VOLUME LXVII NUMBER 1

INDIAN FORESTER

JANUARY, 1941

THE EFFICIENCY OF IRREGULAR STOCKING

BY M. V. LAURIE, CENTRAL SILVICULTURIST,
FOREST RESEARCH INSTITUTE.

(Paper written for the Fifth Silvicultural Conference held in October, 1939.)

This somewhat controversial subject has been introduced for four main reasons, namely:

(*i*) To try to dispel to some extent the prevalent idea that working on evenaged systems is necessarily more intensive, efficient and up to date than working on an irregular system such as selection or one of its modifications.

(*ii*) To show that if conditions of regeneration and silviculture permit working by a selection or irregular system, the indications are that such a system will not only probably give higher returns in cash from the forest, but that work is not likely to be more dispersed and may even be more concentrated than in a regular system, and should be capable of execution with a smaller staff.

(*iii*) To draw attention to the fact that the present tendency to convert most of our forests to "Uniform" regardless of the condition of the growing stock and the sacrifice involved, may in certain circumstances not only be wasting the potentialities of the existing growing stock but may finally, when conversion is complete, result in a system that is less efficient than if conversion had tended to go in the opposite direction, namely towards a true selection type.

(*iv*) Incidentally to make a plea for the treatment of forest crops more upon their merits and according to their natural requirements instead of adopting systems of wholesale conversion by which the potential increment of the existing growing stock is largely wasted.

In Europe since the war there has been a great change in outlook as regards silvicultural systems. Previously in many parts of Germany and France evenaged systems either with regeneration by clear-felling and planting or by natural regeneration under a shelter-wood were general. Such systems are comparatively simple to work and, in the case of poor lands or badly stocked forests where natural regeneration is difficult to obtain, they often provide the most rapid means of improving the forest. Later, however, there has been a marked reversion from such relatively unnatural methods of management. The disaster that overtook the evenaged spruce forests in Saxony emphasised the danger of soil deterioration in pure evenaged crops and the gradual realisation of the many advantages of the "back-to-nature" principle of GAYER, as evidenced by the results of EBERBACH in his "modified selection method" (Vorratswirtschaft), MOLLER'S "continuous forest" system (Dauerwald), and VON KALITSCH'S famous work at Bärenthoren, to mention only a few, are mainly responsible for this change in outlook in Germany. In Switzerland the selection system has been firmly established for many years, having been more or less forced upon the country originally by the danger of starting uncontrollable erosion by clear-felling in steep country, but, as in Germany, it is gradually being realised that such irregular systems are highly efficient for producing the finest large-dimension timber and high returns per acre.

In a recent special issue of the *Zeitschrift fur Weltforstwirtschaft* (3) devoted to German forestry, the necessity for more natural methods of forest management is stressed again and again. Clear-felling is now practically prohibited by state order except in special emergency cases. A proper "biological balance" is insisted upon which must not be upset by such drastic treatment as clear-felling, and modified or intensive selection methods, treating the crop according to its natural requirements so as to enhance the increment on every acre, are advocated.

Nowhere, however, as far as I can ascertain, have any actual comparative experiments been concluded to prove that the yield and particularly the money returns from irregular crops are higher than from evenaged crops. The question is now being studied in Germany, particularly at the Prussian Forest Research Station, though

it will be many years before definite results are obtained. On theoretical grounds, however, the yields from an irregular forest should be higher.

The arguments in favour of an irregular system have been very well stated by BOURNE (1) and may be summarised as follows:

(1) *There is a Saving of Space.*—Even in the most light-demanding of crops, there is some sharing of space when there is an irregular canopy. The more shade-bearing the species, the greater is the amount of space saving that will occur. To quote from Bourne's paper, "As Schlich more or less recognised, *any space saved in irregular woods is most economically utilised by preserving a larger number of immature trees to grow to maturity than is possible in a regular forest. In consequence, the proportion of the older and larger classes in relation to the younger and smaller is raised, the wasteful thinning of many sound immature trees being obviated and the annual or periodic yields of mature tree increased, the increase in value often greatly exceeding that in volume.*"

In India, purely from the "space-saving" aspect of the question, it is probable that very little advantage would be gained in the case of strong light-demanders such as teak in its moister habitats, though in the drier parts of the teak range, teak regeneration is found to be relatively shade-bearing. Coppice teak in dry areas also grows undesirably fast as a uniform crop to start with, producing excessively wide ringed poles of poor quality in its first ten years or so and some shading would be beneficial in producing a more reasonable rate of growth. Sal regeneration is moderately shade-bearing especially in the drier parts of the sal zone (e.g., parts of Bihar and Orissa), and there is little doubt that considerable space saving will occur in irregular sal crops in such localities. In the case of Deodar the same principles apply, while the extreme shade-bearers such as Spruce and Silver Fir would show this advantage to the greatest extent.

(2) *The material can be exploited at its most paying size in irregular working while in a uniform crop all sizes on the ground have to be exploited, often at much less remunerative sizes.*—It is probably generally not realised how great is the variation in size in a mature evenaged properly thinned crop. The following figures, for

example, taken from the "stand tables" of sal, teak and deodar give an idea of the range of sizes found on the ground in an evenaged crop of 20 inches mean diameter (basal area basis), which would be felled in *final fellings only*.

Diameters.	Sal		Teak		Deodar		Selection fellings
9"—10" ..	1	24%	..	16%	..	22%	100%
10"—12" ..	2		1		3		
12"—14" ..	8		3		7		
14"—16" ..	13		12		12		
16"—18" ..	20	38%	20	45%	19	40%	
18"—20" ..	18		25		21		
20"—22" ..	16	28%	18	31%	17	28%	
22"—24" ..	12		13		11		
24"—26" ..	5·5	10%	5·5	8%	6	10%	
26"—28" ..	2·5		1·5		2		
28"—30" ..	1		1		2		
30"—32" ..	1		..		..		
Totals ..	100·0		100·0		100		

Thus a crop of 20 inches mean diameter may have from 16% in the case of teak to 24% in the case of sal of the stems below 16", and the stems in such a crop range from 10" to 30". Where there is a price increment and where 20" has been shown to be the most paying diameter the loss due to felling trees of sizes differing widely from the optimum diameter is obvious. In irregular working the sizes felled can be selected within a small range according to what is most paying, and this source of wastage avoided to a great extent.

(3) *Contrary to general belief the actual amount of work, and the area to be worked over each year may be less than in a clear felling or "uniform" system of working.* Thus, in a forest worked by clear-felling on, say, a 120-year rotation with a 100-acre annual coupe there will be work on 100 acres of final felling with planting, another 200 acres of weeding and early tending, and 6 to 8 thinnings in the course of the life of the plantation, i.e., annual works over 900 to 1,100 acres. In selection working on the same total area of forest with a 20-year felling cycle, all operations, exploitations, thinnings,

cleanings, etc., are done in the one annual coupe which in this case would be 600 acres, or on a 30-year felling cycle only 400 acres. Apart from this greater concentration of operations into a single area, far fewer trees have to be felled in order to give the same final yield. Also fewer trees have to be removed in thinnings, on account of the lower proportion of the smaller sizes in the growing stock. As a large percentage of the trees felled consist of the bigger and higher-priced sizes the returns are correspondingly greater, quite apart from any claims that may be made regarding saving of space [vide (1) above].

Bourne works out a case of a uniform forest regenerated under the shelterwood-compartment system with a 120–year rotation and a 30-year regeneration period and shows that the annual area to be worked over totals up to about 1/10th of the forest. In selection working on the other hand only one-twentieth would be worked over on a 20-year felling cycle.

W. Ammon (4) gives the following example illustrating the above points (extracted verbatim from the English abstract in Forestry *Abstracts* I, 1939, p. 30):

"Although the author believes that high forests managed under selection produce a larger volume of timber than under any other silvicultural system, he does not attempt to prove this; but endeavours to show that, assuming equal-volume production under selection forestry and "exploitation" forestry, the former is more profitable under comparable conditions. The following are the main lines of the argument as put forward in Chapter V of the paper:

"The selection system does not involve higher costs of management. Since selection forests contain a relatively low percentage of small-sized material, less money need be spent on tending young growth and on thinnings. Marking of fellings, felling and logging, contrary to widespread belief, also require less labour. To prove this, Ammon works out a theoretical example comparing the normal yield under the clear-cutting and the selection system respectively (on the assumption that the selection forest is of the Emmental type), in areas of 120 ha. with a total volume production of 1,430 cu. m. each. The crop consists of Quality III Mountain Spruce worked, in

the case of the clear-cutting system, on a rotation of 120 years; and the total annual yield under this system, calculated from Flury's yield tables, amounts to 10,200 trees from a felling and thinning area of 21 ha., the average size of the trees felled and thinned being 0.140 cu. m. In the area managed under the selection system the yield is obtained from 1,430 trees only on 12 ha., the average size of trees felled being 1 cu. m. AMMON assumes a felling cycle of 10 years, as commonly practised in Emmental. Thus the clear-cutting system compares unfavourably with the selection system, since the former involves the felling of 7 *times as many trees on twice the area for the harvesting of the same volume.* The author admits that selection forestry requires higher skill in management, but claims that this is more than counterbalanced by the large amount of labour involved in clear-cutting systems. This example brings out the fact that the normal yield under the clear-cutting system consists of many more trees; it is also essential to note that the maxima and the approximate modes of the bell-shaped volume distribution curves (volume of yield obtained from 120 ha./diam. classes) correspond roughly to the 30-cm. and 50-cm. diam. classes under the clear-cutting and the selection systems respectively. On the other hand, the maximum of the price-size-graph as constructed by AMMON also coincides approximately with the 50-cm. diam class. The author calculates for the above example a total net annual value production in Swiss francs of 21,700 under the clear-cutting and 34,100 under the selection system respectively—an approximate ratio of 100: 157; the average net value/theoretical cu. m. being 15.17 Fr. Sw. in the former case and 23.84 Fr. Sw. in the latter. The calculations are admittedly rather rough and rest in part on purely theoretical assumptions; so they are supplemented by a detailed account of the expenditure, yield, income and changes in capital value of the Steffisburg selection forest during the period 1914—34, which shows the theoretical calculations to be fairly correct in actual practice."

This result, it may be noted, is obtained without considering the advantages of saving of space and hence greater mean annual volume increment per acre that is claimed for most selection working. Had this been allowed for, the advantage of selection working might be even greater.

(4) A fourth advantage of selection-grown timber is the more even growth throughout life. As BOURNE has shown, (5) timber grown in uniform crops is excessively wide-ringed in early years and narrow-ringed later on, while the typical selection forest tree has much more regular-spaced rings throughout life. This implies an increasing current annual increment with age, the maximum increment being added to the tree when it is approaching its most valuable size.

These are the main theoretical advantages claimed for working forests on an unevenaged system. CHAMPION (2) in his reply to BOURNE'S original article pointed out certain obvious limitations with which we are faced in India. The first and most important of these is the regeneration problem. Many of our forests worked in the past by "selection fellings" (as *distinct from the selection* system proper) failed to produce adequate regeneration. Obvious instances are the moist deciduous teak-bearing forests, the moister types of sal, chir-pine and the semi-deciduous Padauk-bearing forests of the Andamans. A first essential of an unevenaged system is ease in getting regeneration when and where wanted. (There is actually no need for such regeneration to be of natural origin, if it can be obtained artificially at reasonable cost.)

Another factor affecting the decision as to whether conversion should proceed in the direction of regular or irregular crops is the condition of the forest in respect of its stocking with valuable species. Where, as in the mixed deciduous forests of Bombay, Madras and Coorg, the crop consists of a small proportion of teak in mixture with a larger proportion of species of lower value, and where regeneration of an irregular crop is impossible to attain, conversion to an evenaged system by clear-felling and planting is obviously the most rapid way of improving the productivity of the forest. Where, however, as in many of the drier sal and teak types, the stocking is regularly improving by natural regeneration under selection working (e.g., in parts of Orissa and in the Central Provinces) it is probable that greater financial returns with less sacrifice of immature stock will be obtained if the conversion is a gradual one towards a true selection type.

There are, it must be admitted, not many forests in India of which it can be said that we know how to regenerate them under an unevenaged system of working, or to which for one reason or another an unevenaged system would be applicable. (The other papers written for this item of the Conference Agenda nearly all describe instances where an unevenaged system is inapplicable or undesirable.) Wherever there is a chance, however, of securing natural regeneration under selection working, then the probable advantages of an irregular system should not be lost sight of.

A very common condition of the growing stock in the drier sal and teak types especially is one resulting from past "selection fellings" or "selection-cum-improvement" fellings the yield from which was, not infrequently, inadequately controlled. This has generally resulted in an absence of mature and nearly mature sizes and an excess (proportionately) of the younger sapling, pole and middle-aged classes. The fact that, under such a system the younger age-classes have increased to such an extent indicates that it should not be difficult to get regeneration under an irregular system. At present, the tendency almost everywhere in such forests, when it is found that selection yields are falling short, is to convert by clear-felling, and it is precisely under these conditions that conversion is least justified. Whether the ultimate system is to be regular or irregular, the needless sacrifice of cutting down these predominantly young crops, wasting their potential productivity while flooding the market with low-priced small-sized stock, cannot be justified merely for the sake of obtaining a series of regular age classes.

All forms of conversion, whether from the existing irregular forests to a proper selection type with suitably distributed diameter classes, or to a uniform type with a complete series of age-classes, involve an inevitable sacrifice in the course of adjusting the age-class proportions. This sacrifice can be very great if, as in the instance given above, large quantities of immature woods are cut down in clear-fellings. It can be minimised by treating the crop on its merits, making the best use of the existing crop on the ground and, if conversion to "uniform" is considered ultimately desirable by postponing conversion until the majority of the crop has reached the best paying exploitable size, the crop being treated in the meanwhile by intensive selection methods,

If, on the other hand, conditions of regeneration are such that an irregular system is likely to be finally possible, there appears to be little doubt that this should be aimed at as being more efficient, involving less labour and giving higher returns. The sacrifice in attaining a proper distribution of diameter classes is likely to be much less than in converting to uniform.

The main principle of the "intensive selection methods" that are being employed more and more in Europe now is that every part of the forest should be treated in such a way as to produce the maximum possible increment. Questions of the distribution of age-classes are considered to be of secondary importance. Intensive silviculture according to the natural requirements of the crop on the ground is practised, blank areas being regenerated and all tendings and thinnings directed towards obtaining maximum increment in every compartment. The logical result is that if every acre of a forest is producing its maximum increment, the annual yield will be a maximum.

Conditions in India, however, do not permit of anything like such intensive working as is contemplated in European practice, but this should not be a reason for neglecting the principle of treating crops according to their rquirements as far as is practical. It should not for instance be considered a sufficient justification for clear-felling a well-stocked predominantly young crop, purely for the sake of getting a regular series of age-classes. A careful study by the working plans officers of the distribution of diameter classes and of the occurrence or otherwise of natural regeneration in adequate quantities under selection methods of working should make it possible in most cases to decide whether ultimately a regular or irregular type of forest is to be preferred, but where there is any doubt; it would appear that an irregular type of working is likely to give higher returns and involve less sacrifice in attainment.

CHAMPION (2) in his reply to Bourne's note on the efficiency of irregular stocking concluded by saying:

"With silvicultural knowledge and conditions what they are in India to-day, the alternatives in practice are a reversion to selective logging regardless of regeneration, or the application to the forest on a large scale of assumptions which ought first to be tried out thoroughly on an experimental scale.

"If these opinions are correct, then it follows that research work should be got under way *now*, to make a start on the accumulation of the data which will be needed when it becomes practicable to consider going

over (*not* reverting) to irregular systems of management. As noted, a commencement has been made on permanent sample plots and more and more attention is being given to ecological survey: much of the natural regeneration studies under way should be equally valuable for either type.

"My answer to the query heading this article* is accordingly that, for the present, conversion from most unmanaged or virgin forests in India should continue towards the roughly-evenaged forms, before the times or the forests are ripe for further progress to the irregular form of genuine managed selection forests."

While agreeing in general with the expression that "conversion from most unmanaged or virgin forests should continue towards the roughly-evenaged forms," that is not a true descripion of what is actually happening in many forests at the present time. As already mentioned, the results of ineffectively controlled selection and improvement fellings in the past has often been a partial conversion to a roughly evenaged condition, and the tendency now is to take these partly converted predominantly juvenile crops and finally "convert" them by clear-felling. This, as has already been pointed out, is most wasteful, and causes a serious reduction in productivity of the forest by encroachment on growing capital.

Turning to the question of research, it is very important that we should determine definitely which way conversion should go in the case of the types of forest mentioned in the last paragraph. Comparative plots starting with similar stocking are required in which clear-felling methods are compared with selection working on a basis which, while maintaining the yield at an arbitrary figure (as financial considerations would undoubtedly demand in practice), will permit the building up of a full series of age-classes in the plot until a true "selection-forest" is obtained. Such experiments would have to cover long periods of time, and results in terms of yield would have to be corrected according *to a representative scale of relative prices for* different sizes, to give a true idea of the financial results. It is suggested that such experiments should be started wherever there is any possibility of getting regeneration under an unevenaged system. Furthermore in cases (e.g., some of the Blue Pine forests of the N. W. F. Province) where natural regeneraton technique under irregular forest has alternated with conversion to uniform, or where although

*"Which way conversion?"

uniform methods may have replaced irregular systems, natural regeneration under the latter is not impossible, research should be directed towards the improvement of regeneration technique under irregular canopy in case the advantages claimed for irregular working can be secured.

As CHAMPION mentions, some statistical results of selection working will be obtained from the tree-increment plots that have recently been established in unevenaged forest. It is pointed out, however, that these forests are merely being worked by "selection fellings" at present and can scarcely claim to be representative of the "selection system" with its thinnings among the smaller sizes and its control of the different diameter classes so as gradually to approach the ideal distribution as far as it is known.

My plea, therefore, is that we should not rush into "conversion to uniform" regardless of silvicultural possibilities simply because it is considered up-to-date, efficient or intensive, because that is not necessarily true. It is, in Europe for instance, definitely *démodé*. The alleged advantages of irregular working should be considered, and in any forests where irregular working might be feasible, the large sacrifices of future revenue that are inevitable in any form of complete conversion should be avoided during the period while the necessary information regarding proper selection working is being obtained by experiments—the forest crop being treated meanwhile on its merits on "safety-first" principles with controlled selection fellings, allowing a gradual improvement of the growing stock, supplemented by regeneration by artificial or natural means of understock areas.

REFERENCES

1. BOURNE, R.—"The Efficiency of Irregular Stocking"—Empire For. Journ., XIV (1935), pp. 215—227.
2. CHAMPION, H. G.—"Which Way Conversion?"—Empire For. Journ., XV (1936), pp. 25—28.
3. ANON.—Zeit. f. Weltforstwirtschaft III (1936), Pts. 11-12 (English summaries to articles)—see pages 656 (*Goering*), 665 (*Von Kendell*) 740 (*Mantel*), 795 (*Abetz*), 803 (*Rübner*), 817 (*Vanselow*), 885 (*Vietinghoff-Reisch*), 935 (*Weck*), 959 (*David*).

4. AMMON, W.—"The Selection Principle in Swiss Forestry: The Results of 30 Years' Management of Selection Forests,"—Supplement No. 17 to Ztschrft. des Schweizerischen Forstvereins, 1937, pp. 108 (German). English abstract in "Forestry Abstracts" I, i, p. 30.

5. BOURNE, R.—"A Problem of Regular Forests"—Empire For. Journ., XIV, I (1935), 10—18.

THE CAPTURE OF WILD ELEPHANTS

By a Correspondent

One of the most spectacular methods of capturing wild elephants is by the "Khedda" method. Mysore State, in whose forests scores of wild-elephant herds roam, stages "Khedda" operations once in a while, usually to secure elephants for its forest depots, but also in honour of distinguished guests to the State. One such "Khedda" happened recently, when H. E. the Viceroy visited the State.

The word "Khedda" means a trench. It is generally ten feet wide at the top and eight feet deep, enclosing an area of about eight acres of forest land, through which elephants in their wild state move up and down a path to which they are accustomed.

Stockades.—The "Khedda" is generally located in a place where water facilities and easy communications are available. Near one of the gates, preferably near the end of the forest, a funnel-shaped stockade is constructed with huge logs. The wings of this stockade vary in length from 100 to 200 yards. In a convenient spot along the trench where the ground is level, another round stockade of very strong timber is built. This stockade, which is called the "Roping Stockade," will be about 40 feet in radius and will be connected with the funnel stockade by a gate which can be opened and shut at will.

The first operation connected with a "Khedda" after the completion of the stockade is the driving operation. For this, about 1,500 persons, consisting mostly of forest people, are collected. A week before the actual drive takes place, trackers are sent to find the location of herds and their normal movements. The trackers note every herd they see in their wanderings and select for the drive a

convenient herd containing young and healthy animals and moving towards the "Khedda" rather than away from it.

With the 1,500 drivers ready in the forest depot and a herd having been located, the driving operations begin. The drivers are moved up and distributed at intervals of a hundred feet, beginning from where one of the wings of the funnel-stockade ends and completely enclosing the herd until the other wing of the stockade is reached. The area thus surrounded generally covers about 20 square miles or more. The driver is to be vigilant throughout his duty at his post and, during nights, each man has to keep up a good fire. Patrolmen inspect this line of drivers so that everyone is alert and at his post. Since the blazing fires near each of the 1,500 drivers form a continuous chain, the elephant herd usually keeps to its own feeding-place and will not try to break through the cordon and escape.

The Driving Operations.—When everything is ready, on the afternoon fixed for the final drive, the driving party consisting of "kumkis" (trained tame elephants used in the "Khedda" operations) and the beaters, a hundred strong, start driving the elephants towards the enclosure. The beaters will have to be alert and move from cover to cover carefully, keeping their eye on a likely tree to which they can run and climb up in case the herd takes an obstinate stand or turns back.

At a given signal, a man sets fire to the heaps of combustible material that have been placed between the wild herd and the forest. A hundred voices simultaneously shout at that moment, empty tins are sounded to a devilish din, bamboo rattles are shaken and blank cartridges are fired. The effect of this dreadful noise on the quietly grazing herd is remarkable. Disturbed out of their feeding, the elephants begin to move and their natural direction will be away from the fire and the noise, which will take them straight into the open gate of the funnel-stockade.

The chief of the beaters, who will be on a "kumki," directs his attention to the leader of the elephant herd, which is generally an old cow-elephant. A few well-directed buckshots prevent it from facing the driving party and keep it moving towards the gate. When once the leader passes the gate and gets into the stockade, the rest of the

herd thoughtlessly move on. As soon as the last elephant is in, the gate is dropped and fastened strongly. While this is going on, a party of a hundred men moves along the trench and the men, posting themselves at intervals of 25 feet set ablaze piles of logs soaked in kerosene oil which have been kept in readiness. This fire is kept on day and night and is never allowed to die out throughout the "Khedda" operations.

Roping the Wild Herd.—On the day set apart for the roping operation, a number of "kumkis" with *mahouts* on their backs get into the funnel-stockade and drive the wild ones towards the roping stockade. With much resistance and wild stampeding, the herd moves towards the gate that connects the ropping stockade and the funnel-stockade. With renewed efforts the "kumkis" work and at last the herd enters the roping stockade. After the "kumkis" have also got in, the gate is closed and secured strongly.

In the meantime, strong hemp ropes, three to four inches thick, are kept ready. The "kumkis" pick out a wild elephant and hold it firm between their bellies so that it cannot move even an inch. While the elephant is in this position, an expert roper approaches its hind legs under cover of the "kumkis" and slips a noose over one of them and tightens it, while the loose end of the rope is fastened to a stanchion fixed to the ground inside the stockade. The other hind leg is also similarly tied. After the legs are secured, a rope is passed around the neck of the wild animal by a *mahout* on a "kumki" and the other end of it is tied to the belly of a strong "kumki."

In this manner all the wild elephants inside the stockade are roped. Roping is anything but a pleasant job. It takes a very long time and to put a single rope on the leg of a wild elephant may take as much as three hours at a time, so persistent a wild elephant can be in refusing to submit its leg to be roped. The danger element is also very great here. A mere kick from the leg of a wild elephant and the roper lies crushed to death. The slightest careless movement and the next second the roper is lifted up with a trunk and dashed down to pieces on the ground below.

The last operation in the "Khedda" consists in removing the roped animals into the open. Each wild elephant engages the attention of four or five "kumkis" and, escorted by them, it moves out

Fig. 1

A herd of wild elephants inside the funnel stockade.

Photo: G. Nanja Nath, Mysore.

Fig. 2

With its neck and legs tied, a captive elephant is conveyed out of the stockade into the open.

Photo: G. Nanja Nath, Mysore.

of the stockade. Struggling at every foot and yielding inch by inch, the huge animal is led to a clearing in the forest and tied to a strong tree there. Closely following come the other elephants that have also been roped and they are also tied to trees in the clearing (*see* Figs. 1 and 2, Plate 1).

This marks the close of a "Khedda" and the only remaining thing to be done is to tame the captive wild elephants and make them useful to man.

NEW OR LITTLE-KNOWN PLANTS FROM KUMAON

By Mukat Behari Raizada, m.sc.

Forest Research Institute, Dehra Dun

A previous article on this subject has already appeared in the *Indian Forester*, LXVII (1934), 189—196. In the present paper are assembled various distribution notes on the Kumaon flora that have been prepared over a period of several years. They represent records of previously described species not hitherto known to occur in Kumaon. Eminent botanists like Wallich, Royle, Falconer, Jacquemont, Edgeworth, Thomson, Strachey and Winterbottom, Davidson, Madden, Duthie, Osmaston, etc., have travelled widely through and collected extensively in the area for which these new records are being published. Their exploration covers a period of one hundred years and the discovery of new records of plants is a reminder that there are few areas in India, including those which are best known, which can be said to be exhausted in a botanical sense. The species enumerated in the present communication are all deposited in the Dehra Dun Herbarium unless otherwise indicated.

Incidentally it may be mentioned that the affinity of the North-West Himalayan flora with that of China is becoming strikingly apparent as plants of these two regions are more closely and critically explored and studied. This fact is further borne out by the discovery of *Xylosma congestum* (Lour.) Merr. (the "find" of *Sinomenium acutum* Rehder and Wilson having already been reported in the previous publication) a species described and uptill now confined to China and Japan.

In conclusion, it is my pleasant duty to thank Dr. N. L. Bor, Forest Botanist, Forest Research Institute, Dehra Dun, for kindly going through the manuscript and Mr. V. Narayanswami of the Botanical Survey of India, Calcutta, for all possible help while the author compared some of these specimens in the Sibpur Herbarium.

FLACOURTIACEAE

Xylosma congestum (Lour.) Merrill in Philip. Journ. Sc. XV (1919) 249. Croton congestum Lour. Fl. Cochinch. (1790) 582. excl. descr. fruct. Xylosma racemosum Miq. Ann. Mus. Bot. Lugd. —Bat. ii (1865-6) 155. Hisingera racemosa Sieb. and Zucc. Fl. Jap. Fam. Nat. i (1843) 169.

Known so far only from China, Japan and Formosa.

"Kafkote, Almorah, 30-7-1900, Inayat 24242."

"Pithoragarh, East Almora, 5,000 ft., 28-12-1931, A. E. Osmaston 1469."

"Pithoragarh, East Almora, July, 1932, A. E. Osmaston 1497."

A large shrub or a small evergreen, thorny tree; branches glabrous; thorns stout, sharp pointed, up to 2 cm. long. Leaves ovate or rhomboid, rarely ovate-elliptic, shortly stalked, up to 5 cm. long, 2—3.5 cm. wide, rounded at the base, rather coriaceous, remotely serrate, acute, glabrous, nervation prominent on both surfaces; petiole up to 7 m.m. long. Flowers diœcious, in axillary cymes which may be up to 2 c.m. long, minute; peduncles densely hairy. Male flowers 3-4 m.m. across, stalked; sepals 5, imbricate, about 2 m.m. long, ovate, margin slightly ciliate. Petals O. Stamens numerous, anthers attached by the back. Female flowers not seen. Fruit a globose berry, dark-brown when ripe, the size of a small pea, tipped with the remains of the persistent style, 2-seeded.

ONAGRACEAE

Raimannia drummondii Rose in U. S. Dept. Agric. Contr. Nat. Hist. VIII (1905) 331. Syn. Oenothera drummondii Hook.

A biennial or annual herb from an oblique or decumbent base, densely soft-pubescent, 30—60 cm. high. Leaves 7—12 cm. long, elliptic, oblong or oblanceolate, acute or obtuse, either gradually or abruptly tapering into a short petiole, entire or slightly toothed,

densely pubescent at least when young. Flowers axillary, not fragrant, nocturnal; buds erect. Calyx tube about 5 cm. long, very narrow, often split into 4 segments and reflexed. Petals 5—7 cm. across, bright yellow, showy, twisted in bud. Stamens 8, with long conspicuous anthers. Ovary 4-celled, elongated. Capsule 2.5—3.5 cm. long, narrowly cylindric, obtusely 4-angled with numerous seeds in two rows.

A native of Texas but now cultivated and naturalized at Naini Tal and elsewhere in Kumaon. Also found in the Chamba State, vide R. N. Parker, Dehra Dun Herb. No. 21672, 21673.

In addition to Oenothera rosea Sims. [Hartmannia rosea (Ait.) G. Don.] mentioned in Strachey's Catalogue of Kumaon Plants and Oenothera drummondii HK. described above, O. stricta Ledeb., O. odorata Jacq. and O. tetraptera Cav. have also become naturalized in various parts of Kumaon, e.g., at Ranikhet, Almora and Naini Tal.

CUCURBITACEAE

Cyclanthera pedata Schrad. in Index Sem. Hort. Gotting. (1831).

"Jeolikote, Kumaon, 4,000 ft., 22-10-1912, N. Gill 470 in Herb. Calcutta."

An annual herb climbing by tendrils to a height of 120 cm. or more; Stems grooved, angular, glabrous, branched. Petiole 2.5—5 cm. long. Leaves pedately 5—7 foliolate, the leaflets sessile or nearly so, lanceolate or oblong-lanceolate, serrate, acute at both ends, the central up to 7 cm. long, 4.5 cm. wide, rough on both surfaces; tendril 3-4 parted. Flowers monoecious minute, inconspicuous, green or cream. Male flowers small, racemose or panicled; peduncle equalling or exceeding the leaves. Calyx cup-shaped, 5-toothed, minute. Corolla rotate, deeply 5-parted. Stamen 1, with a 1-celled anther. Female flower solitary, very shortly peduncled; Calyx and corolla as in the male flower. Ovary obliquely ovoid, 2-celled with 2-ovules in each cell; style short. Fruit about 3 cm. long, nearly sessile, somewhat softly prickly or smooth, oblong or obliquely ovoid, and attenuate at the base, green becoming yellowish—white, 2-locular, edible.

Native of Mexico but now cultivated and running wild in Kumaon. It has also become naturalized at Mussoorie (Tehri Road, Landour), vide M. B. Raizada, Dehra Dun Herb. No. 79634 and R. R. Stewart 17020.

UMBELLIFERAE

Pleurospermum benthami C. B. Clarke; *Fl. Br. Ind. ii, 703.*

Described from material collected by Wallich in Nepal.

"Near the Ralam Glacier, 13,000—14,000 ft., Kumaon, 28-8-1884, J. F. Duthie 2954."

A herb 60—90 cm. high. Leaves pinnate or sub-2-pinnate; pinnae 2.5—8 cm., pinnatifid; lobes distant, large, coarsely serrate. Fruiting pedicels up to 4 cm. long. Fruit about .7 cm. long, ellipsoid, dorsally compressed, lateral ridges widest.

The identification of this interesting umbellifer has been confirmed by Mr. C. Norman of the British Museum (Natural History), London.

COMPOSITAE

Erigeron crispus Pourr in Mem. Acad. Toulose iii (1788) 318;

Erigeron linifolius Willd. Sp. Pl. iii (1804) 1955; Fl. Br. Ind. iii, 254.

"Naini Tal, July, 1876, Col. Davidson s.n. in Herb. Dehra."

"Naini Tal, August, 1923, H. G. Champion, Dehra Dun Herb. No. 70802."

A stout, erect, softly villous or nearly glaborous herb with close set leafy stem and branches. Heads numerous, subpaniculate, .7—1.2 cm. in diameter. Achenes sparsely silky.

Gamble in Fl. Madras p. 683 and Haines in Bot. Bihar and Orissa, p. 465, call this plant Conyza ambigua DC. As the genera Conyza and Erigeron are defined by Bentham and Hooker in Genera Plantarum and by Hoffmann in Engler, Pflanzenfamilien, this plant would appear to be an Erigeron and not a Conyza.

The fact that this plant is widely distributed throughout the country, from the plains to 7,000—8,000 ft. in the hills is in opposition to the statement made by Sir J. D. Hooker in the Flora of British India loc. cit. that it is merely an escape in India.

ASCLEPIADACEAE

Asclepias curassavica Linn; Fl. Br. Ind. IV, 18; Raizada in Jr. Ind. Bot. Soc. XV (1936) 159.

"Malwa Tal, Naini Tal Division, U.P., 3,500 ft., 3-12-26, A. E. Osmaston 1320."

An erect herb or undershrub with opposite lanceolate or oblong-lanceolate leaves, bright orange-red flowers, beaked and stalked follicles about 7.5 cm. long.

A native of the West Indies now naturalized in various parts of India specially in waste damp places and along water-courses.

SCROPHULARIACEAE

Linaria cymbalaria Mill. Gard. Dic. ed. VIII (1768) n. 17.

"Naini Tal, 6,800 ft., 28-6-1922, R. N. Parker, Dehra Dun Herb. No. 26218."

A perennial, glabrous, tender herb; stems long, trailing and rooting at the joints. Leaves ivy-shaped, cordate—orbicular or reniform, 5—7-round-lobed, glabrous, palmately-veined, 1—1.7 cm. in diameter; petiole slender, longer than the blade. Flowers light-blue, .7 cm. long, axilliary, solitary on long, glabrous stalks. Calyx gamosepalous, lobes lance-shaped, persistent. Corolla gaping, with a short tube and yellow palate which closes the tube; mouth yellow, hairy; nectary purple, as long as the calyx; tube spurred at the base. Stamens 4, ascending, in two pairs; anthers oblong. Capsule globose, splitting from the top, with black, ridged, wrinkled seeds.

A native of Europe but now naturalized on walls in Naini Tal; also in Simla, vide R. N. Parker 2784.

LENTIBULARIACEAE

Utricularia uliginosa Vahl. Syn. U. affinis Wt.; Fl. Br. Ind. IV, 330. So far reported only from the Western Deccan Peninsula and Orissa.

"Someswar, Kosi River, West Almora Division, Kumaon, 26-8-1923, H. G. Champion, Dehra Dun Herb. No. 73095."

A small, rather obscure species with bluish-purple flowers and conical spur. The linear—oblong obtuse leaves and small bladders are very evanescent. Scape slender, simple, 4—12 cm. high, 3—6-

flowered. Spur straight, conical, slightly curved forwards. It is leafless when in flower.

AMARANTACEAE

Gomphrena disperma Standly in contr. U. S. National Herb. XVIII (1917) 91.

"Ranikhet, Dist. Almora, 23-8-1923, H. G. Champion, Dehra Dun Herb. No. 36658."

An annual or perennial, much-branched, prostrate or procumbent herb. Tap root stout, very long. Branches 20—100 cm. long, slender, sparsely or densely appressed pilose. Leaves opposite, shortly stalked, entire, oval-oblong, or oval-obovate, 1.5—5 cm. long, upto 1.5 cm. wide, acute or mucronate, attenuate at the base, bright green, pilose-sericeous, often glabrate on the upper surface. Spikes usually solitary, terminal or axillary, subglobose or short cylindric, 9-13 m.m. in diameter, each subtended by 2 acute sessile leaves which are usually shorter than the spikes. Flowers hermaphrodite, each with one bract and two bracteoles. Bracts rounded-ovate, acuminate, white, often denticulate; bracteoles 5—6 m.m. long about 3 times as long as the bracts, thin, acute-obtuse, white (very rarely purplish-red), narrowly cristate at the apex, the crest extending along the keel for only a short distance, denticulate or laciniate. Perianth 5—partite, usually equalling the bractlets, densely lanate, the lobes oblong-linear, acuminate or attenuate, white. Staminal tube 5-fid, commonly included, anthers 1-celled. Style elongate, stigmas 2, slender. Seeds 1.5 m.m. long, reddish-brown, shining.

Indigenous to Central America (east coast) and in the Greater Antilles. Naturalized along roadsides in Ranikhet; also near Bhalupani alongside the Nun Nadi, Dehra Dun, vide M. B. Raizada Dehra Dun Herb. Nos. 80245, 80246, 80247, 80081, 80082 and 80083.

This species has been much confused with G. decumbens Jacq, another tropical American plant, but can be distinguished from it by the following characters:

In G. disperma the crest of the bractlets is widest much below the apex if they are perceptibly widest anywhere, the flowers thus appearing pointed or acuminate. Moreover the bractlets are much longer than the flowers; while in G. disperma they are equal or even shorter

than the Perianth. In the latter species the crests are widest at or near the apex of the bractlets and the flowers thus appear obtuse or merely acutish. In G. decumbens furthermore the flowers are frequently tinged with red or are yellowish while in G. disperma they are dull, clear white.

JUGLANDACEAE

Engelhardtia spicata Bl.; Fl. Br. Ind. V, 595.

Hitherto reported from Nepal to Burma, Java and Cochinchina.

"Malwa Tal, Naini Tal Division, Kumaon, 4,000 ft., 4-12-1926, A. E. Osmaston 1322."

"Gori Valley, near Jauljibi, East Almora, 2,000 ft., 19.3.1932, A. E. Osmaston 1487."

"East Almora Division, Kumaon, 9-5-1933, Bis Ram 2159."

A large tree reaching usually twice the height of an ordinary E. colebrookeana Lindl. from which it also differs in having larger, shortly acuminate and quite glabrous (when mature) leaflets.

In the absence of any authentic herbarium specimens Mr. Osmaston omitted to describe this species in his Forest Flora for Kumaon although he suspected its occurrence in the area (see Osmaston l.c. p. 516 under the distribution of E. colebrookiana Lindl.).

ORCHIDACEAE

Calanthe alpina Hook. f.; Fl. Br. Ind. V, 850.

Previously known from the Eastern Himalayas (Sikkim).

"Dwali, 9,000 ft., 17-7-1920, H. G. Champion s. n. in Herb. Calcutta."

Pseudobulb ovoid, subcylindric, 2—2.5 cm. long, with 2—3 transverse rings. Larger leaves broadly oblanceolate, blade 15—20 cm. long, inflorescence overtopping the leaves. Flowers 4—5, rather distant, 10—15 cm. across. Sepals and petals white, tipped green; lip when flattened out semicircular, edge incisely fringed, dull-red, its base and the cylindric spur pale-yellow.

SCITAMINEAE

Phrynium parviflorum Roxb.; Fl. Br. Ind. VI, 259.

Known so far from the Eastern Himalayas, Singbhum, Puri. Chota Nagpur, Concan and Malaya Peninsula,

"Adhwarsot, Haldwani Division, 2,500 ft. May, 1924. H. G. Champion, Dehra Dun Herb. No. 39496, 39497."

An erect usually gregarious herb with slender stem 60—150 cm. high from a tuberous rhizome, bearing single terminal large oblong-cuspidate leaf about 30—45 cm. long, 15—20 cm. broad, shining on both surfaces, shortly cuspidate. Flowers small, white, the staminode tipped with yellow, aggregated into a sessile lateral head 2.5—5 cm. in diameter, near the middle or top of the stem.

AROIDEAE

Colocasia fallax Schott.; Fl. Br. Ind. VI, 524.

Previously reported from the Eastern Himalayas, Silhet, Assam, Singbhum, Ranchi and Palamau.

"Dogadda, South Garhwal, 5-7-1919, A. E. Osmaston 1101."

A very glaucous herb 30—45 cm. high growing in shady and moist places with very big corms, freely rooting at the nodes. Leaves ovate or elliptic-ovate 10—25 cm. long 10—20 cm. broad (in our specimen), base rounded with a shallow sinus. Petiole much longer than the blade. Spathe erect about 15 cm. long; tube green about 2—2.5 cm. long, suddenly contracted to the yellow very acuminate limb.

LEMNACEAE

Lemna paucicostata Hegelm.; Fl. Br. Ind. VI, 556.

Previously reported from various parts of India but not from Kumaon.

"Dwarahat, Almora District, 4,000 ft., 20-6-1923, R. N. Parker, Dehra Dun Herb. No. 36565."

A minute, gregarious, floating, acquatic herb. Fronds about 2 m.m. long, oblong or obovate-oblong, somewhat oblique at the basal end, rather thin, nearly flat on both sides. Root sheath with a minute wing on either side at the base; root cap acute. Ovule solitary, orthotropous.

CYPERACEAE

Cyperus eleusinoides Kunth; Fl. Br. Ind. VI, 608.

Hitherto recorded from various parts of India, South of the Himalayas, Ceylon; tropical and warmer parts of Asia, Africa and Australia.

"Hawalbagh, Kumaon, 10-9-1849, Jameson s.n. in Herb. Dehra Dun."

"Gunai, Kumaon, 4,000 ft.; 30-8-1885, J. F. Duthie 4484."

An erect, glabrous perennial with a short horizontal rhizome covered with scale sheaths which tend to break up into fibres. Inflorescence a large compound umbel; spikelets densely spicate; rachilla of spikelets narrowly winged. Nut ellipsoid, trigonous.

Cyperus digitatus Roxb.; Fl. Br. Ind. VI, 618.

Known from the Punjab to Assam, Ceylon and most tropical regions.

"Hawalbagh, Kumaon, 30-8-1845, Jameson s.n. in Herb. Dehra Dun."

A tall glabrous herb; rhizome short. Stem triquetrous above, smooth, striated, covered at the base with coarse, not fibrous, usually dark leaf-sheaths. Leaf-blades linear, tapering above to an acuminate apex. Umbels large, compound, rays divaricate; spikes cylindric, spikelets very many, linear, 6—40-flowered; wings of rachilla conspicuous but soon deciduous. Nut oblong-obovate.

Fimbristylis squarrosa Vahl. Fl. Br. Ind. VI, 635.

Known so far from different parts of India but not reported from Kumaon.

"Bhimtal, Kumaon, 20-8-1923. H. G. Champion, Dehra Dun Herb. No. 44922."

A little tufted herb, similar to F. dipsacea Benth. superficially. Stem 5—20 cm., striate. Spikelets all oblong, 2—3 m.m. long, in umbels often 5—10 cm. in diameter with bracts usually short or as long as the umbels. Glumes flat broadly oblong with the keel produced into a long squarrose awn equal to or exceeding the blade. Nut orbicular-obovoid, smooth, compressed, pale-yellow. Style base swollen with remarkable pendulous villi all round.

A SHORT NOTE ON THE SAL REPRODUCTION IN THE UPPER BHABAR TRACT, AT RAIMATONG, BUXA DIVISION, BENGAL

By M. M. Sarkar, Forest Ranger.

Introduction.—The problem of Sal reproduction in Bengal has come into prominence since 1930 in the light of similar experiments carried out in Kamrup, in the Province of Assam, and, since then, series of experiments have been carried out in almost all the Sal

Divisions of Bengal. A period of ten years has elapsed but this important problem still remains unsolved for any practical applicability in the Working Plan. It is the vital issue of the management of Sal Forests and there is no reason for disappointment although one-third of a service life has been spent to achieve the goal without any substantial success. It is now a common belief that the protection of our Forests from fire and stoppage of grazing in the past is partially responsible for the change of our forests into moister type with consequent increase of evergreen undergrowth and a great number of pernicious climbers which contributed largely to the complete absence of sal regeneration. Instead of going into details of several types of forests the present article will be confined mainly to the experiments that are being carried out in the "Upper Bhabar Sal" Forests at Raimatong and the summary of results obtained therein with a view to enlighten the readers of the real situation.

Locality.—The area adjoining the foothills of the Himalayas on the north with two small rivers, the Dima and the Gangutia, on the east and west running to a distance of three miles to the south, is known as Raimatong Bhabar Tract. It is about eight square miles in area, slightly undulating to the south with an average elevation of 800 feet. The climate is moderate with very little frost and having a rainfall of over 150 inches, generally distributed from April to October. The soil is composed of sandy loam with a fair amount of humus. Sandstone boulders are scattered over the surface soil. Water-level is very deep—generally more than 50 feet—with adequate drainage in the subsoil.

Flora.—The forests may be called as typical of the Upper Bhabar Sal type. It is comparatively open and sal occurs only in patches with all age-classes present. The associates of sal in the top canopy mainly consist of the species of the "Dry-mixed" type viz., *Lagerstroemia parviflora, Schima wallichii, Sterculia villosa, Stereospermum tetragonum, Terminalia belerica, Amoora wallichii* and the like. The top canopy is more than 125 feet in height.

The second floor is about 60 feet high and contains mainly *Amoora rohituka, Dillenia pentagyna, Premna* spp., *Aporosa dioica, Wrightia tomentosa, Olea dioica, Callicarpa arborea, Careya arborea* and a pole crop of the spp. of the top canopy.

The undergrowth is very dense and shoulder-high. Sau (*Pollinia ciliata*) constitutes the principal species with a fair amount of *Panicum spp., Clerodendron infortunatum, Alpinia allughas, Mucuna pruriens, Millettia auriculata, Leea crispa* and *Acacia pennata.* Thatch is also present in small quantity in the more open places.

A certain amount of sal recruitment is present. Profuse germination of sal seedlings takes place every year, specially in a good seed year but the percentage of survival is disappointingly small and almost negligible. This is due to suppression by dense masses of undergrowth in the rains. Regeneration of miscellaneous spp. is also very unsatisfactory, probably due to hot burning which has been carried out since 1930.

Experiments.—An Experiment to obtain natural reproduction of sal was first started in the year 1930. Since then a series of experiments have been carried out with a view to finding the solution. A short description is given below of the operations carried out and a summary of the results obtained up to date in these experimental plots with the writer's personal remarks.

An area of 5 square miles was taken up in 1930 in the Bhabar Tract and hot burning carried out every year since then. Canopy and weed growth were left untouched. The idea for this hot burn was to change the "sau" type of undergrowth into thatch with a full stock of sal recruitment of the "carroty" stage all over the area. Fire protection would then start for these seedlings. After burning annually for the last 10 years it has been found that the recruitment of sal seedlings is still far below par to commence fire protection. The "sau" grass has not also been changed in to thatch. On the other hand, a fair amount of evergreen undergrowth, e.g., *Clerodendron infortunatum, Alpinia allughas, Leea crispa, Mukuna pruriens, Millettia auriculata* and *Acacia pennata* are invading the area in large numbers. Thatch has also come in small quantities in the more open places but "sau" is still predominant all over the area. On observation it has been noticed that sal germinates profusely every year specially in a good seed year but the seedlings fail to survive due to the dense mass of undergrowth and the heavy shade of the over-head canopy. They die in the rains in large numbers and the percentage of survival is very small. It has also been noticed

that towards the eastern side where the overhead canopy is comparatively light and the undergrowth is not very dense, probably due to heavy grazing in the rains by the cattle of the permit-holders, which reduce the growth of the weeds to a great extent, the percentage of survival is much more hopeful. This indicates that burning alone will be of no effect to the recruitment in the Bhabar Tract, whereas burning combined with heavy grazing in the rains helps the recruitment considerably. Also thatch is not essential for the natural reproduction of sal.

In the year 1931 an area of four acres was laid out in a hill slope at Santrabari where the mother trees of sal were present only on the top of the hill and completely absent on the slopes. The flora was typical of the Bhabar Tract with "sau" as the principal undergrowth. In the first year all the miscellaneous trees were felled and the canopy was made very open with only a few sal trees left on the top of the hill to serve as mother trees. A hot burn was done every year in March-April. Evergreen undergrowth, e.g., *Assamlota* (*Eupatorium odoratum*), *Clerodendron infortunatum*, *Ageratum* spp. and the like, that made their appearance every year together with the coppice shoots of the miscellaneous spp. were cut back once in the rains and again in the cold weather to bring in thatch and reproduction of sal. This helped to some extent to eradicate the evergreen undergrowth but "sau" is still prominent although a certain amount of thatch has appeared. The recruitment of sal in this area is considerable and it is now time to think of fire protection. In view of the time taken for such a result and the annual cost of cutting the evergreen weeds and copice shoots of misc. spp. for so many years, the result does not appear to be satisfactory for any practical application over a vast area on a large scale. This has, however, helped to find out that opening up the canopy alone fails to bring in thatch or recruitment and that weeding during rains is essential for the survival of the sal seedlings.

In 1936 a 10 acre plot was laid out inside the Bhabar Tract where the canopy was raised by removing the trees of the second storey and a heavy thinning was done in the upper canopy in the first year at the time of formation, followed by a late burn. The evergreen undergrowth was also cut every year and left to dry for

two months or so before burning so as to get a very hot burn over the area. It resulted in a good crop of sal recruitment within one year but instead of the change of undergrowth into thatch a dense mass of "sau" appeared together with a fair amount of evergreen undergrowth. Due to hot burn in the second year a certain amount of the unestablished seedlings died and no response towards the growth of unestablished seedlings to the "carroty" stage was forthcoming. The recruits suffered considerably in the rains due to suppression by the dense mass of weed growth. Their height growth was poor and they looked unhealthy with very dark green leaves.

In the opinion of the writer better results would have been obtained if the evergreen undergrowth in this plot could be cut in the rains instead of in the cold weather. This experiment shows that opening up the canopy helps a good deal in obtaining sal recruitment of the unestablished stage but fails to change the undergrowth into thatch or to further the growth of the seedlings from the unestablished stage to the "carroty" size. This also shows that thatch is not at all necessary for the natural reproduction of sal.

In 1937 an area was taken up inside the Bhabar Tract where weeding was done during the rains. The canopy was opened up in 1938. This gave excellent results as regards the recruitment and the growth of the seedlings. The area is now fully stocked with seedlings of the unestablished stage and some have even attained the "carroty" stage. All sal mother trees should now be removed.

In 1938 a plot of two acres was laid out inside the Bhabar Tract and weeding was done during the rains in six feet wide lines at an interval of eight feet in between the lines. This gave immediate response as regards recruitment. In January, 1939, the canopy was opened up. Sal seeds were broadcasted in the lines in July 1939. Weeding was carried out during the rains last year and again in the current year. The result is quite satisfactory so far. The growth of the seedlings in more open spaces is much faster than in places under shade of a denser canopy. The area is now fit for the removal of all trees of the upper canopy.

In the same year (1938) another plot of four acres was laid out in the Bhabar Tract and the canopy was fully opened up. Concentrated grazing was allowed on this plot. The area was divided into

three sub-plots and the following operations were carried out in addition to grazing:

(1) Sal seeds were broadcast in July.
(2) Sal seeds were dibbled in July.
(3) Nothing was done except grazing.

It is yet premature to form an idea of the results but it seems quite certain that grazing helps in reducing the intensity of undergrowth and thereby serves as weeding and helps the growth of the seedlings. The complete opening up of the canopy failed to bring in thatch and the area has been invaded by Assamlota.

Two more plots on the lines of weeding in the rains were added in the Bhabar Tract in 1939. One 15-acre plot was given to three grazier villagers (each house having ten cows for free grazing) for two weedings in the rains free of cost in lieu of the free grazing allowed for 10 cattle per villager.

In January, 1940, the canopy was opened up on the principle of a maximum gap equal to the height of a tree. The thinned-out trees were sold and the debris was burnt in April. As a result the area was completely covered with sal recruitment in July. Weeding during the rains promises excellent result within one year. It seems quite certain that these recruits will survive after the rainy season weeding and opening up of the canopy and further opening will be necessary in the next cold weather. It is yet too early to form any opinion but this experiment indicates that the opening up of the canopy and rainy season weeding are both very efficacious to sal recruitment even in the first year. It will perhaps prove the best method of obtaining natural reproduction of sal within the shortest period.

Another plot of two acres was laid in 1939 where rainy season weeding is being carried out in six feet wide strips at intervals of 12 feet in between the strips. Canopy has not been opened up in this plot. The growth and reproduction are more effective in the open places in comparison with that under shade of the overhead canopy.

Conclusion.—To conclude the results of the experiments described above, it can be definitely said that the soil is quite suitable

for the reproduction of sal in the Bhabar Tract. Annual burning with a view to bring in thatch by the eradication of "sau" and other evergreen undergrowth is definitely ineffective. Burning alone will take a very long time to raise the sal seedlings to the "carroty" stage. On the other hand, presence of thatch is not an essential condition to obtain reproduction and evergreen undergrowth is definitely harmful to the safety of the new recruits and to the growth of unestablished seedlings. "Sau" appears to be a better type of undergrowth and reproduction is possible in "sau" grass areas. Open canopy is essential for the growth of the seedlings. If sufficient seed-bearers are present, broadcasting of sal seeds is unnecessary. Weeding in the rains helps early reproduction and the growth of the seedlings. Hot burning helps reproduction but retards the growth of the unestablished seedlings. Early burning acts as weeding for the growth of the unestablished seedlings. Grazing reduces the weed growth and thereby affords a cleaner bed for the growth of the seedlings.

It is now an open question to decide whether it is advisable to depend on burning alone for a long period to obtain reproduction or to carry on rainy season weeding combined with complete opening up of the canopy within a limited period, say of three years, and get the desired results as well as revenue by the disposal of the trees. The cost of this method of reproduction would be about half that for the creation and upkeep of a plantation three years old.

TIMBER PRICE LIST, NOVEMBER-DECEMBER, 1940
(INDIAN STATES)
(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE).

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing ..	*Tetrameles nudiflora* ..	Cochin ..	Logs ..	
"	"	Travancore ..	Logs .	
Benteak ..	*Lagerstræmia lanceolata*	Cochin ..	Logs ..	Re. 1-2-5 per c.ft.
" ..	" ..	Mysore ..	Logs ..	
"	"	Travancore ..	Logs ..	Re. 0-10-4 per c. ft.
Bijasal ..	*Pterocarpus marsupium*	Barwani ..	Logs ..	Re. 0-8-0 per c.ft.
" ..	" ..	Cochin ..	Logs ..	
" ..	" ..	Dhar ..	Logs ..	
" ..	" ..	Hyderabad ..	Logs ..	Re. 1-2-0 to 1-8-0 per c.ft.
" ..	" ..	Indore ..	Beams 14′ × 18″	Re. 0-8-0 per c.ft.
" ..	" ..	Mysore ..	Logs ..	
" ..	" ..	Patna ..	Logs ..	
" ..	" ..	Travancore ..	Logs ..	Re. 1-0-9 per c.ft.
Deodar ..	*Cedrus deodara* ..	Patiala ..	Sleepers 10′ × 10″ × 5″ ..	Rs. 7-4-0 each.
Dhupa ..	*Vateria indica* ..	Cochin ..	Logs ..	Re. 0-11-0 per c.ft.
Gamari ..	*Gmelina arborea* ..	Tripura ..	Logs ..	Re. 1-0-0 to 1-8-0 per c.ft.
Gurjan ..	*Dipterocarpus* spp. ..	Cochin ..	Logs ..	Re. 0-9-3 to 0-11-0 per c.ft.
" ..	" ..	Tripura ..	Logs ..	Re. 1-0-0 to 1-2-0 per c.ft
Haldu ..	*Adina cordifolia* ..	Barwani ..	Logs ..	Re. 0-6-0 per c.ft.
" ..	" ..	Bansda ..	Logs ..	Rs. 30-0-0 to 55-0-0 per ton.
" ..	" ..	Banswara ..	Logs ..	Rs. 1-4-0 to 9-0-0 per log.
" ..	" ..	Bhopal ..	Logs ..	Re. 0-7-0 to 0-9-0 per c. ft.
" ..	" ..	Cochin ..	Logs ..	
" ..	..	Dhar ..	Logs ..	
" ..	" ..	Mysore ..	Logs ..	
" ..	" ..	Patna ..	Logs ..	
" ..	" ..	Travancore ..	Logs ..	
Hopea ..	*Hopea parviflora* ..	Cochin ..	Logs ..	Re. 1-1-3 to 1-8-8 per c.ft.
" ..	" ..	Travancore ..	Logs ..	Re. 1-0-1 per c.ft.
Indian Rosewood ..	*Dalbergia latifolia* ..	Barwani ..	Logs ..	Re. 0-12-0 per c.ft.
" ..	" ..	Bansda ..	Logs ..	Rs. 35-0-0 to 70-0-0 per ton.
" ..	" ..	Cochin .	Toplings ..	Re. 1-6-2 per c.ft.
" ..	" ..	Dhar ..	Logs ..	
" ..	" ..	Kishengarh	Logs ..	
" ..	" ..	Mysore ..	Logs ..	
" ..	" ..	Patna ..	Logs ..	
" ..	" ..	Travancore ..	Logs ..	Re. 0-13-0 to 1-3-1 per c.ft.

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Irul ..	*Xylia xylocarpa* ..	Cochin ..	Logs ..	Re. 0-12-11 to 1-8-8 per c.ft.
,, ..	,, ..	Travancore..	Logs ..	Re. 0-13-0 per c.ft.
Kindal ..	*Terminalia paniculata* ..	Cochin ..	Logs ..	Re. 1-3-8 per c.ft.
,, ..	,, ..	Mysore ..	Logs ..	
,, ..	,, ..	Travancore..	Logs ..	Re. 0-12-5 per c.ft.
Laurel ..	*Terminalia tomentosa* ..	Barwani ..	Logs ..	Re. 0-6-0 per c.ft.
,, ..	,, ..	Bansda ..	Logs & squares	Rs 26-0-0 to 50-0-0 per ton.
,, ..	,, ..	Bhopal ..	Logs ..	Re. 0-10-0 to 0-14-0 per c.ft.
,, ..	,, ..	Cochin ..	Logs ..	Re. 0-14-10 to 1-6-0 per c.ft.
,, ..	,, ..	Hyderabad ..	Logs ..	Re. 1-0-0 per c.ft.
,, ..	,, ..	Indore ..	Sawn material	Re. 1-4-0 per c.ft.
,, ..	,, ..	Mysore ..	Logs ..	
,, ..	,, ..	Patna ..	Logs ..	
,, ..	,, ..	Travancore..	Logs ..	Re. 0-14-8 per c.ft.
Mesua ..	*Mesua ferrea* ..	Cochin ..		
,, ..	,, ..	Tripura ..	Logs ..	Rs. 1-8-0 to 2-0-0 per c.ft.
Sal ..	*Shorea robusta* ..	Cooch Behar	Logs & scantlings	Re. 0-8-0 to 1-12-0 per c.ft.
,, ..	,, ..	Patna ..	Logs ..	
,, ..	,, ..	Tripura ..	Logs ..	Re. 1-0-0 to 1-4-0 per c.ft.
Sandan ..	*Ougeinia dalbergioides* ..	Bansda ..	Logs ..	Re. 31-0-0 to 80-0-0 per ton.
,, ..	,, ..	Patna ..	Logs ..	
Semul ..	*Bombax malabaricum* ..	Banswara ..		
,, ..	,, ..	Cochin ..	Logs ..	
,, ..	,, ..	Cooch Behar	Logs & scantlings	Re. 0-2-0 to 0-12-0 per c.ft.
,,	,, ..	Rampur ..	Planks 6′×1′×1¼″ ..	
,, ..	,, ..	Travancore..	Logs ..	
,, ..	,, ..	Tripura ..	Logs ..	Re. 0-4-0 per c.ft.
Sissoo ..	*Dalbergia sissoo* ..	Banswara ..		
,, ..	,, ..	Cooch Behar	Logs & scantlings	Re. 0-8-0 to 0-12-0 per c.ft.
,, ..	,, ..	Hyderabad..	Logs ..	Re. 1-0-0 to 1-6-0 per c.ft.
,, ..	,, ..	Rampur ..	Planks 6′×1′×1¼″ ..	
Teak ..	*Tectona grandis* ..	Barwani ..	Logs ..	Re. 0-8-0 to 1-0-0 per c.ft.
,, ..	,, ..	Bansda ..	Logs ..	Rs. 25-0-0 to 70-0-0 per ton.
,, ..	,, ..	Banswara ..	Logs ..	Rs. 1-4-0 to 4-0-0 per log.
,, ..	,, ..	Bhopal ..	Logs ..	Re. 0-14-0 to 1-6-0 per c.ft.
,, ..	,, ..	Cochin ..	Logs ..	Re. 1-8-8 to 3-7-4 per c.ft.
,, ..	,, ..	Indore ..	Sawn material	Re. 0-15-0 to 1-14-0 per c.ft.
,, ..	,, ..	Mysore ..	Logs ..	
,, ..	,, ..	Travancore..	Logs ..	Re. 0-12-4 to 1-10-0 per c.ft.

VOLUME LXVII 51 NUMBER 2

INDIAN FORESTER

FEBRUARY, 1941

A HOLIDAY IN WARTIME

BY E. A. GARLAND

The essence of a holiday is that it should suit the individual concerned. For an official office slave, perhaps the best of holidays is one which gives ample opportunity for the leisurely marshalling of ideas, assisted by discussions with friends, personal or in books. For, as Vera Brittain has written in *Thrice a Stranger,* "it is only by cultivating the garden of his mind in the same leisurely pace as he needs for cultivating the garden of his house, that a man's ideas grow gradually but certainly to completeness and perfection." Far be it from me to suggest perfection or even merit for these jottings, except perhaps in so far as they are quotations from others. "My thought and feelings are not mine but came from others and I can give to others."

Difference in tempo has been one of the most remarkable of the many ways in which this war has, until now, differed from its predecessor. For this dissimilarity the essential differences between Europe and India, as well as the altered outlook of a man of forty from that of an eighteen-year-old youth, may be largely responsible in the individual case. Yet recollections of seniors in the last war suggest that for them also, as for the youngsters, intervals in active participation in the war were filled only by equally hectic "leave" and that a genuine holiday was almost unknown. Therefore, a recent opportunity for a complete escape from work seemed the more precious, not only because it is quite possible that no such opportunity may ever recur but because it offered a chance for quiet, concentrated thought on all those problems which, in these critical days, buzz so insistently at the backs of the heads of almost all of us. It is in the hope that the conclusions reached may be of some interest to others that this brief summary has been written.

A cardinal error in the past seems to have been the general indolence, by which we have all left the fashioning of our futures far too

casually in the hands of those who happen to have adopted politics as a profession. Whatever the future may hold, it is certain that this "war" will continue long after the actual close of hostilities and that the most important phase will only commence with "peace." The sole justification for all the devastation, destruction and waste is that out of Death there may arise Life and that those who survive the war should be ready to start fashioning a more acceptable way of life as soon as the last "all clear" signal has been sounded. Therefore, while armies must be trained for the campaigns of 1941 and 1942 against Hitler, it is of the utmost importance that each one of us, of whatever trade, creed, profession or sex, in civil life or in Government service, should be as certain as possible what it is we want. Here in India we are privileged to have a breathing space in which to make up our minds. How long this may last none can tell. It is urgent, therefore, that we make the most of this chance. On those of us with families and friends in Europe, who therefore can more fully appreciate this present agony, the duty lies heaviest to do all in our power to be worthy of their sacrifices and to be ready to do all we can to help to fulfil their faith by rebuilding a better world.

Labels.—Another ruinous laziness, to which in the past all too many of us have succumbed, has been our casual acceptance of labels and slogans. How many of us could give any coherent account of the differences in fundamental beliefs which distinguish a Communist from a Nazi, or either from a Fascist? How many Englishmen could define the essential differences between Labour, Liberal and Conservative? What was the basic distinction in Spain between a Republican and a Nationalist? What do we really mean by Democracy, or by Totalitarianism? Yet having thus catalogued the varied policies or philosophies—call them what you will—of our time to our lazy satisfaction, we all too often consider the application of such labels adequate justification for utterly condemning some as the embodiments of all evil, and for sanctifying others as compact of all righteousness. Thus we blind ourselves to the good points in some of the former and to the black spots in many of the latter. Even a little thought, a little examination of the evidence, will show that such wholesale condemnation or approval is clearly not the truth,

"And anyway, thought Mrs. Miniver, I'm sick and tired of being offered nothing but the same old choice. Left wing. . . . Right wing. . . . it's so limited; why doesn't it ever occur to any of them that what one is really longing for is the wish-bone?"

This laziness is specially dangerous because of the tinsel appeal which many of the least worthy doctrines make to impetuous youth and even to unthinking elders. It may be fatal through its failure to set out with reasoned arguments, more acceptable ideals, which will not merely secure the acquiescence of the common man, but be responsive to the best and most formative minds. As Edward Sackville West has pointed out, the programme which both the Communist and Fascist doctrines entail is "arrogant, scornful, trustful and brave; it is also superficial—the philosophy of the Short Cut. Now, if history teaches anything, it is that all short cuts end with maddening obduracy and in spite of Carl Marx, in a simple return to the outside of the maze; for a short cut is a form of violence and violence is for ever sterile—a recoiling spring of self-hatred." Unfortunately, by comparison, the policies of the "democratic" governments all too often appear deplorably cautious, uninspiringly pedestrian and even at times to sink to mere political expedients, directed solely by the fear that the majority of the people of the nation may change their mind.

We shall exult if they who rule the land
Be men who hold its many blessings dear,
Wise, upright, valiant: not a servile band
Who are to judge of danger which they fear
And honour which they do not understand.

(*Wordsworth in* 1806.)

Destinations.—Fundamentally, beneath all the various "-isms," it seems that there are only two creeds. Under one the ideal state is that human societies should be based on those of ants or bees. The common man should work, not because of conviction that the ultimate aim is good, but to some blind end, he knows not what nor why. Single men or groups of men arrogate to themselves the sole right to order other men's lives in all respects as those in power may deem fit. For the common folk, theirs not to reason why, theirs but to live and die. This, as Gerald Heard has pointed out in *The Third Morality,*

is the logical sequence to the teachings of materialistic science, which have gradually accumulated during the last 300 years into what he terms "Mechanomorphism." Of course there is a bait to lure men into this slave trap and that bait is, with perfect irony, the promise of freedom—freedom for each to do as he lusts, without restraint. "In short, there is no limit put by any rule of conduct deduced from materialistic science on any extravagance of individualism. The individual is the only fully real thing. He must, to satisfy himself, take everything he desires; otherwise he is repressed, unhealthy, morbid; a creature who will give way to other-world fantasies and superstitions unworthy of a free man. Of course this leads to an intersocial anarchy as violent as the international anarchy, and in the end the conflicting individuals—after many have destroyed each other—fall under one tyrant who by superior strength and cunning has managed to crush them. They then have all their liberty taken away and become his slaves, his means. But, adds Natural Selection, that is all right. The fittest has survived; the strong has been selected and the weak have been weeded down and out." (*ob. cit.*)

Opposed to this is the ideal of a fellowship of men aiming at the enrichment of the common life. In such a fellowship, equal and free men voluntarily entrust the shaping of their joint destiny to the initiation of chosen individuals, secure in their rights and accountable to others who have equal rights. That is merely the superficial organisation. It is of the utmost importance to realise that the truth upon which such an organisation rests is profound and comprehensive: an ethic, resultant from and firmly based upon, a genuine cosmology. There is a truly remarkable coincidence of the conclusions at which many thoughtful and eminent men of to-day have arrived. As Gerald Heard has summarised in *The Third Morality,* "the general aim is the individual's realisation of his unity with all life and being: his realisation that the universe is alive and that every creature, himself included, is part of that life." Compare with this what Aldous Huxley says in *Ends and Means*: "To the casual observer, the world seems to be made up of great numbers of independent existents, some of which possess life and some consciousness. From very early times philosophers suspected that this commonsense view was, in part at least, illusory. More recently investigators, trained

initiative

in the discipline of mathematical physics and equipped with instruments of precision, have made observations from which it could be inferred that all the apparently independent existents in the world were built up of a limited number of patterns of identical units of energy. An ultimate physical identity underlies the apparent physical diversity of the world. Moreover all apparently independent existents are in fact interdependent. Meanwhile the mystics had shown that investigators, trained in the discipline of recollection and meditation, could obtain direct experience of a spiritual unity underlying the apparent diversity of independent consciousness. They made it clear that what seemed to be the ultimate fact of personality was in reality not an ultimate fact, and that it was possible for individuals to transcend the limitations of personality and to merge their private consciousness into a greater, impersonal consciousness underlying the personal mind.

"Concerning the relation between the underlying physical unity and the underlying spiritual unity it is hard to express an opinion. For our present purposes the important fact is that it is possible to detect a physical and a spiritual unity underlying the independent existents (to some extent only apparent, to some extent real, at any rate for beings on our plane of existence), of which our commonsense universe is composed. Now it is a fact of experience that we can either emphasise our separateness from other beings and the ultimate reality of the world or emphasise our oneness with them and it. To some extent at least our will is free in this matter. Human beings are creatures who, in so far as they are animals and persons, tend to regard themselves as independent existents, cemented at most by purely biological ties, but who, in so far as they rise above animality and personality, are able to perceive that they are inter-related parts of physical and spiritual wholes incomparably greater than themselves. For such beings the fundamental moral commandment is: 'You shall realise your unity with all being.' But men cannot realise their unity with others and with ultimate reality unless they practise the virtues of love and understanding. Love, compassion and understanding or intelligence—these are the primary virtues in the ethical system, the virtues organically correlated with what may be called the scientific-mystical conception of the world. Ultimate

reality is impersonal and non-ethical; but if we would realise our true relations with ultimate reality and our fellow-beings we must practise morality and (since no personality can learn to transcend itself unless it is reasonably free from external compulsion) respect the personality of others.

"The physical world of our daily experience is a private universe quarried out of a total reality which the physicists infer to be far greater than it. This private universe is different, not only from the real world, whose existence we are able to infer, even though we cannot directly apprehend it, but also from the private universes inhabited by other animals—universes which we can never penetrate, but concerning whose nature we can, as Von Vexkull has done, make interesting speculation guesses. Each type of living creature inhabits a universe whose nature is determined and whose boundaries are imposed by the special inadequacies of its sense organs and its intelligence. In man intelligence has been so far developed that he is able to infer the existence and even, to some extent, the nature of the real world outside his private universe. . . . Individual human beings have been able to transcend the limitations of man's private universe only to the extent that they are relieved from biological pressure. An individual is relieved in two ways: from without, thanks to the effort of others, and from within, thanks to his own efforts. If he is to transcend the limitations of man's private universe he must be a member of a community which gives him protection from the inclemencies of the environment and makes it easy for him to supply his physical wants. But this is not enough. He must also train himself in the art of being dispassionate, must cultivate intellectual curiosity for its own sake and not for what he, as an animal, can get out of it."

Nor is this ideal of realisation of the unity in all life and being inconsistent with individual liberty of expression. As John Hadham has pointed out in *Good God,* "The outlook of a healthy society is made up of an infinity of divergent temperaments and experiences. And the whole will only be a whole if each individual in it makes the whole of his individual contribution according to his individual temperament and experience. A society is a body and not a collection of toe-nails. Now if the parts of our body could speak, they

would reveal the most remarkable variety of opinions. The outlook of the stomach would be extremely limited and essentially materialistic. A flighty stomach would spell disaster, but flighty hair is often more attractive than the best efforts of hair-cream and the hairdresser. And it would be a poor lookout if the nose were always trying to take over the job of the ear. The palate may have a taste for innovation and experiment which would produce catastrophe if it were not continually controlled by the extreme matter-of-factness of the liver.

"So it is in a human society. The attempt to suppress differences can only lead to poverty by preventing each member of society developing to the highest his own contribution. It may be added that the individual conversely can only develop his own contribution in a society in which the other functions are fulfilled by other peoples. If I, as a toe-nail, were always attempting to fulfil the functions of a diaphragm, both functions would be very inefficiently performed.

"Society needs to confer on the individual the right to his liberty, but the individual must concede to society the right to discipline; and progress comes from the perpetual interaction of these two naturally indispensable and mutually conflicting principles. A most ingenious arrangement, for it is obvious that the balance will never stay put for any length of time, and that each successive generation has to work it out afresh for itself, thereby preserving its own interest in life. Where societies attempt to fix the balance for the future the result, sooner or later, is upheaval and so it ought to be.

"So then it is the function in society of one man or group always to be pressing forward; of another always to be seeing difficulties. One man will conceive great schemes; another will see which part of them is at the moment capable of realisation; a third will think only of the ideal. One man will give his whole life to meticulous research; another will seize on the essential points in this research and turn it into an invention useful to all mankind; and the ordinary man, for whom God must have a special affection since he made a world which needs such very large numbers of ordinary men, will go

quietly

quickly on with his daily work, voting all the others a little odd and incomprehensible."

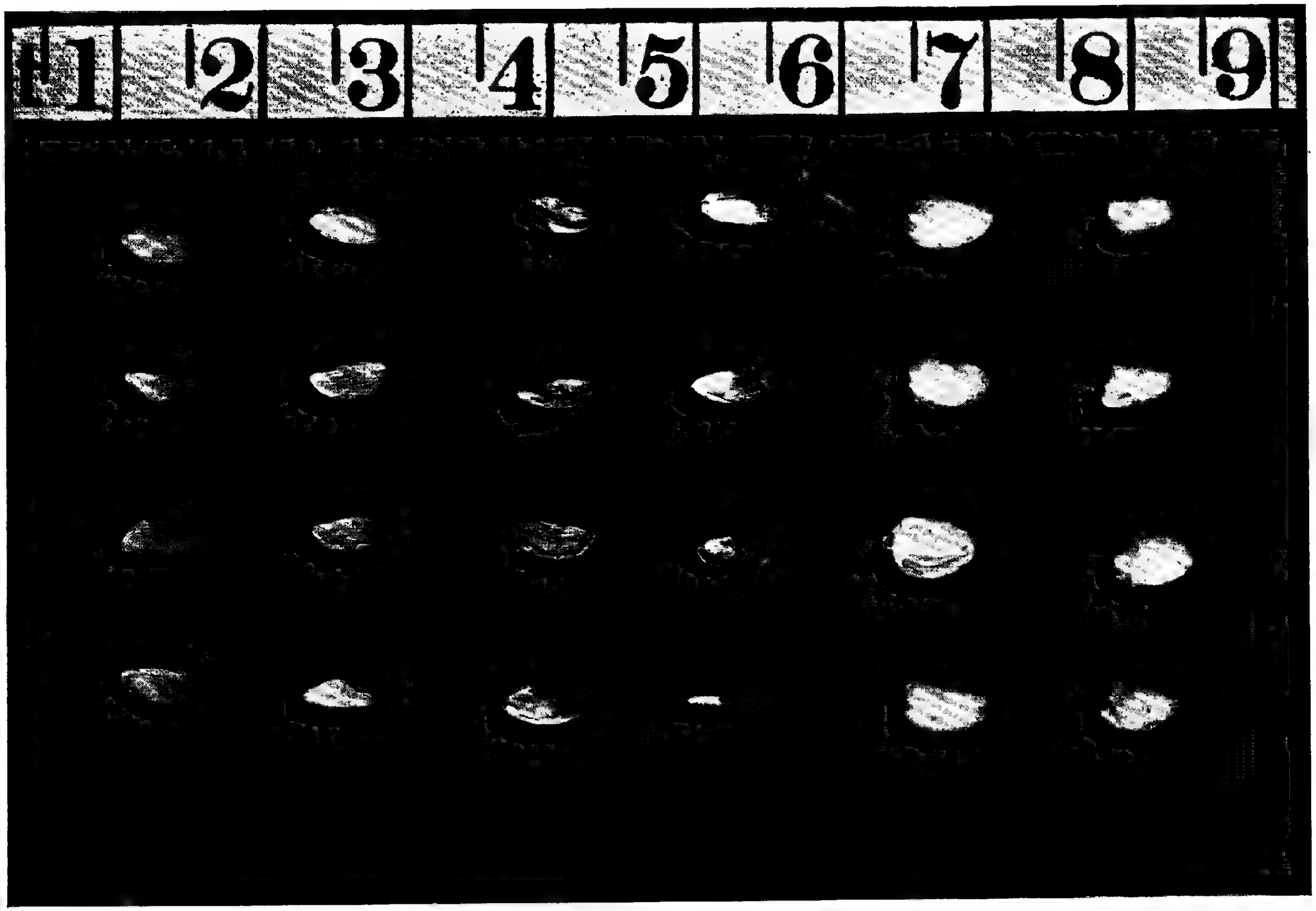
One final quotation may serve to emphasise the sequence underlying the essential, though disciplined, liberty of expression for the individual, the fraternal association among equal men and the cosmology based upon the realisation of unity with all being. This quotation comes from L. K. Elmhirst, writing on the Dartington Hall Experiment in Devon, England. "Besides the need for a sense of adequacy in economic, social and sex life, man has always shown a hunger for some sense of direction in the scheme of things around him and for sense of balance and satisfaction and peace within his soul. When inner feelings, intentions and sensibilities are alive and active and are balanced by reason and a sense of social purpose, a civilization begins to produce something we call personality in the individual and in society something we recognise as culture."

Routes.—To summarise, briefly it is the faith, the belief in the truth of the underlying cosmology, which matters and by which all current routine action of the individual and of the machinery for government should be judged. There are only two fundamental objectives. On the one hand the ultimate sterility of violence: on the other the orderly unity of all life and being: chaos as opposed to cosmos. Surely it should not matter if the individual can best realise this unity, owing to personal upbringing or hereditary, through attendance at a Muslim mosque, a Hindu temple, or a Christian church, or alone with his own thoughts! Is there not here, in this belief, a basic faith to which all can subscribe? For foresters it should have a special appeal in the realisation that the soil itself is a living organism intimately related to man and that the welfare of the one is inextricably bound up with the welfare of the other.

GERMINATION OF NIM SEED (*AZADIRACHTA INDICA A. JUSS.*)

By Jagdamba Prasad, b.sc., ll.b., p.f.s., *Experimental Assistant Silviculturist, F.R.I.*

In an article under the same heading, in the *Indian Forester* of February, 1939, by Mr. M. V. Laurie, Silviculturist, F.R.I., the results of an experiment conducted in 1938 to determine the most suitable treatment of the seed of *Azadirachta indica* to improve the germina



AZADIRACHTA INDICA SEED PRETREATMENT

From left to right: First two columns—Depulped and cleaned, i.e. all pulp washed with cold water and rubbed off with a piece of cloth, air-dried under shade for 24 hours—fruit white in colour. Middle two columns—Depulped, i.e., sticking pulp allowed to dry out—colour dark brown. Last two columns—Whole fruit (untreated control).

Photo: *M. Bakhshi*, 5-9-1939. *Experimental Garden, F.R.I.*

tion were given. The experiment was repeated in 1939 and 1940. The results which confirm the conclusions drawn in the earlier article are given here.

The treatments compared (See Plate 2) were:

A.—Depulped fruits washed and cleaned (cleaned seeds were white in colour).

B.—Depulped fruits not cleaned and washed (seeds were a brown colour after drying).

C.—Whole fruits—control.

Treatments A and B were done 24 hours before sowing and the seeds were air-dried under shade in all cases, as in the 1938 experiment.

The seeds were collected from Dehra Dun on 3rd August, 1939 and 30th July, 1940, and stored in open receptacles, before experimentation, sowings being done after treatment on 6th August, 1939 and 5th August, 1940, respectively, for the 1939 and 1940 experiments, 400 seeds of each treatment being sown in the nursery in eight replicated sets of 50 seeds of each kind in 1939 and sixteen replicated sets of 25 seeds of each kind in 1940. The beds were not watered or shaded and monsoon conditions prevailed.

Germination started in five and seven days for A and B and 11 and 10 days for C respectively in 1939 and 1940 and was practically completed by the 26th and the 32nd day respectively after sowing.

The plant percentages at the completion of germination were as follows:

Year of experiment.	PLANTS PER CENT.		
	A Depulped and cleaned fruit—white in colour	B Depulped fruit brown in colour	C Whole fruit (control)
1938 ...	63	42	13
1939 ...	96	74	11
1940 ...	93	76	24

The differences were all highly significant as determined by the x^2 (chi-squared) test. Mean heights varied from 3.1 to 3.9 inches by the end of the first growing season, but did not show significant differences, as in the 1938 experiment.

Depulped and cleaned seed (white coloured) has consistently proved superior and is considered the best method of pre-treatment of the seed of *Azadirachta indica.*

Although only camels seem to relish the *nim* flavour, rabbits nibbled some of the seedlings causing casualties in the 1938 and 1939 plants. These plants were, however, all killed back by frost eventually in spite of thatched shelters provided. This is, however, the micro-climatic effect of New Forest and does not affect the conclusions reached above.

GARBLED GILBERT

OR

THE KING OF FORESTERIA

Rising early in the morning, we put out a forest fire,
Then our manly form adorning in our work-a day attire,
We proceed without delay,
To the duties of the day.
First we polish off some batches
Of accounts the "babu" hatches,
And absconding "thekadars" we circumvent.
Then if business isn't heavy,
We may hold a Census levee,
Or finish all the "peshi" that's been sent.
Then we probably inspect the current coupes,
With the usual, "Kya bat hai? Boop-a-doops!"
Or receive in ceremonial and state,
An interesting local potentate.
After that we generally,
Climb a mountain from a valley,
For it always seems to happen that the work is at the top,
Where we see the latest markings,
Are disturbed by hog-deer barkings.
We shouldn't go and shoot it, for there isn't time to stop,

But in view of cravings inner,
We go off and shoot our dinner.
To dismiss a naughty Forest Guard we fix a later date;
Spend an hour in titivating,
Though it keeps the memsahib waiting,
For we have to pay a visit to a taluqdar's estate.
Oh! Philosophers may sing,
That a D.F.O. is king,
That of pleasures he has many, and of worries he has none.
But the only sort of pleasure,
That he ever has to treasure,
Is the satisfying feeling that his duty has been done!
After tiffin, making merry,
On our local Nabob's sherry,
If we've nothing in particular to do,
We may visit a plantation,
Or receive a deputation,
Or appoint another Forester or two.
Then we find illicit fellings in our path,
And intimidate the culprit with our wrath.
Then, although it is a duty that we hate,
We turn away "umedwars" at the gate,
Or we interview a Ranger,
Whose range quarter is in danger,
White ants creeping hither, thither, up and down and to and fro,
Or whose Forest Guard on duty,
Has seduced a village beauty;
And it generally happens that her husband gets to know.
We get rid of him, when able,
See repairs done to a stable,
Draft a Plan of Operations, and at half-past twelve, or one,
There may be a tiger roaring, but it won't disturb our snoring;
We've the satisfying feeling that our duty has been done!
Oh! Philosophers may sing,—etc.

ROD.

KANARA FORESTS

BY T. K. MIRCHANDANI

[Being notes of a talk given to the Darwar-Hubli Rotary Club on 24th September, 1940, and Karnatak College Science Association.]

The object of this talk is to interest you in the management of our forests, or, to put it in other words, to make you a bit forest-minded. Very few of us, although living on the borders of one of the richest forest areas in India, realise the value of our national asset. The forests are worked on the principle of perpetual and ever-increasing yield. A gold mine is not inexhaustible. Gold mines give gold and when they are exhausted there is no return as in the case of old Indian gold mines. The forests are, therefore, better than even gold mines as they give us a perpetual return and an ever-increasing one up to their maximum capacity.

The Kanara forests are situated on the south-west edge of the Deccan Plateau abutting the sea on the west, North Malabar Coast on the south and south Konkan on the north. Geologically the underlying rock is metamorphic (quartzites, slate, shale, etc.), with large intrusions of volcanic basalt. The tops of hills are covered with laterite.

The climate is hot, moist and malarious. There is practically no winter except for a short period in December and January. The elevation varies from over 2,000 feet on the landside to sea level on the coast. The country gives an impression of a mountainous land with gently sloping hillsides except in valleys of rivers like Kalinadi, Kaneri river, etc., which are very steep. The rainfall varies from hardly 40 to 50 inches on eastern and northern sides to over 200 inches towards south-west.

The forests of the Kanara District, which cover nearly four-fifths of the whole area of the district, are divided for the purposes of administration into three forest divisions, viz., Northern Division, Eastern Division and Western Division.

The divisions are again subdivided into ranges and ranges into blocks and blocks into compartments. The above divisions are purely administrative in order to facilitate the management of the forests.

There are three distinct types of forests in Kanara:

(*a*) Evergreen type (the tropical rain forest); (*b*) the deciduous high forest; and (*c*) the deciduous pole forest. These divisions are not watertight but one type gradually merges into another, depending on the factors of the locality, specially rainfall and depth of soil.

The evergreen type is biologically and physiologically in the highest state of development. All forests, if properly tended and protected from depredations of fire and reckless cutting, tend to reach this state. In this type of forest the upper canopy is closed. Hardly any sunshine penetrates the forest floor. The trees are covered with climbers and lichen. The forest floor is covered with a dense crop of undergrowth in all stages of development. There is complete absence of grasses. Palms and ferns take their place. The streams and *nallas* in such evergreen patches are perennial. In the hot weather these forests are most pleasant to ramble in. These forests are in a state of unstable equilibrium. If they are cut and burnt they would not reproduce themselves and would degenerate to a drier type. We have only very limited patches of these forests. They are strictly preserved as in the lower valleys of all such evergreen forests, there are the coco palm and spice gardens. The close preservation of these forests is essential for these garden crops. They supply the necessary leaf manure and perpetual source of the water.

The deciduous high forest is by far the most important type of high forest. This is the teak-bearing forest of Kanara and practically 90 per cent. of the revenue of Kanara forests is obtaind by sale of teak. Most of our exploitation is confined to these forests; I shall deal with it later.

The pole forest is biologically the same as the deciduous high forest except that the tree growth is poorer and sparser. This forest is confined to areas of lower rainfall, e.g., Haliyal, Supa and Sirsi Talukas. In addition to the three types mentioned above there are other types of forests, e.g., the minor forest of the coast below Ghats, etc. But it should be understood that the division of these types is not watertight. Each type merges into the other with the change in the geological factors, specially depth of soil and rainfall.

Working of the Forests.—The forests are worked under a definite plan which is sanctioned by Government. The plan may be based

on any basis such as rotation of maximum yield or volume of forest produce, or maximum revenue per acre or maximum convenience of management. The basis usually adopted in India is maximum sustained income per acre subject to the satisfaction of agricultural and grazing requirements of local population. The plan is revised every 10 years. *The prescriptions of the plan are divided into two parts:* (*a*) the exploitation of mature forest in order to get revenue and (*b*) the reproduction of the exploited area with suitable tree species in order to maintain a perpetual yield. For example the forests of the pole area are divided into several "felling series" and each felling series is divided into annual coupes equal to the rotation of the pole area. The annual coupe is marked out and sold standing. The purchaser clear-fells the area. After the purchaser has removed all his timber, fuel, etc., the branchwood and any hollow timber left by him is offered free to villagers to meet their agricultural and domestic demands. After these demands are satisfied remnant material is grouped into *rabs* and burnt.

The reproduction of these clear-felled coupes is obtained (*a*) by *coppice growth from old stools* (nearly 80 to 90 per cent. by this method); (*b*) by natural seedlings from seed of trees which had been felled (this is about 5 to 10 per cent.); and (*c*) by artificial regeneration of selected species by the Forest Department.

(*a*) and (*b*) mentioned above are natural methods and we try to help these by suitable cultural operations. As regards (*c*) we maintain nurseries of important forest species and from them plant up all the burnt patches, i.e., *rabs* mentioned above. A good range forest officer can regenerate by this method as much as 10 per cent. of the area of the coupe. At present the species most commonly planted are teak, sandalwood, laurel, *dindal, karimuttal* and *honni.*

The exploitation of teak-bearing high forests is, however, done departmentally. These forests are extremely valuable. Simple clear-felling would cause a great amount of loss as all trees are not mature for felling. Therefore, in these forests we adopt discriminate fellings, that is, what is technically called selection-*cum*-improvement fellings. The general idea is that a Compartment is taken up and is gone over thoroughly by a trained Forest Officer and a marking gang. All trees which have reached the exploitable size (84 inches

girth at breast height in my Division) or which are likely to deteriorate if not removed, are selected for felling. The marking is controlled by a set of silvicultural rules laid down in the working plan sanctioned by Government and the total number of trees that can be taken out from a given compartment is controlled by calculations of the "possibility" of that forest as worked out by detailed measurements of growth carried out by the working plans officer from the stem analysis of individual trees and/or measurements of sample plots.

The marked trees are girdled to kill them, specially in the case of teak. This girdling seasons the timber and makes it lighter for transport due to drying up of moisture.

A couple of years following the girdling and marking operations the trees are felled and extracted. The felling and transport is carried out by a piece worker and a carting contractor or else both operations are given out on contract to a logging contractor. The whole operation is controlled all the time by trained forest staff who see that there is minimum waste in felling and conversion operations. The felled trees are converted into logs, beams, rafters and mill pieces and are delivered at the sales depot by the contractors who are paid for this work at the contract rates. For example, at the sales depot at Dandeli, the logs are sorted out by length, girth and quality classes and stacked in separate sub-depots. The rafters are classified into I, II and III qualities and stacked separately. The mill pieces, i.e., pieces of timber too small to yield logs or poles are converted in the saw-mill at Dandeli and the sawn material, mostly Railway sleepers, is stacked in seasoning sheds pending disposal.

The logs are sold annually at the sale depot at Dandeli sometime in the first week of December. On the other hand, the sawn material is sold twice annually, i.e., December and May each year.

Methods of Extraction.—The commonest method of extraction is felling by axe, cross-cutting by saw and transport by carts. But this latter is possible in a flat country. On gentle slopes several pairs of buffaloes are engaged to drag logs from the tree stump to the nearest cart track. For still steeper slopes we use winches worked either by animal power or by motor tractors. The above methods of extraction are adopted in my Division where all timber is collected at the rail-head at Dandeli. From Dandeli to Alnavar the timber

is transported by the Dandeli—Alnavar Forest Railway. But in other Kanara divisions, specially the Western Division, whose sales depot is at Karwar in the estuary of Kalinadi, the timber is dragged down-hill by the help of elephants to the nearest wet *nalla* or river whence it is floated down to the Karwar Depot.

The above gives you a rough idea of the methods of exploitation adopted. But this is only a part, and a minor part, of the duties of a forest officer in Kanara. The most important part of his work is the reproduction of teak in the teak high forests from which we extract thousands of tons of teak each year. This is done by selecting patches of forests varying from 50 to 100 acres in each range where the factors of locality are most suitable for the growth of teak and where the present growth is mature or is inferior and whose removal will not entail a great loss. Such areas are clear-felled and all saleable material from them is sold or sent to the sales depot and the remaining slash, i.e., all unsaleable timber and branchwood, bamboos and undergrowth are heaped, dried and burnt. Then the whole burnt area is planted with teak in May-June each year. By this method we are regenerating several hundreds of acres each year in each of the three Kanara Divisions. In due course when these plantations mature, they will, at a most conservative estimate, more than double the revenues at present derived from the Kanara Forests.

I give below in a tabular form the total revenues from the Northern Division of the Kanara Forests for the last 10 years. These figures are about half the total revenue of the Kanara Forests.

KANARA NORTHERN DIVISION

Year	Revenue	Expenditure	Surplus
1930-31	10,52,202	6,13,360	4,38,842
1931-32	9,27,840	6,95,182	2,32,658
1932-33	9,68,131	4,88,091	4,80,040
1933-34	9,56,758	5,04,733	4,52,025
1934-35	10,89,927	5,17,947	5,71,980
1935-36	11,54,434	4,89,210	6,65,224
1936-37	9,86,978	4,22,404	5,64,573
1937-38	8,85,509	4,07,846	4,77,663
1938-39	11,03,478	4,13,427	6,90,051
1939-40	8,79,778	3,79,262	5,00,516

Hitherto, I have talked only about timber yield from the Kanara Forests. But in addition these forests yield the following economic products:

(*a*) All the wood fuel and charcoal we use.

(*b*) All the bamboos and bamboo products.

(*c*) Most of the grasses for industrial purposes.

(*d*) Most of the leaf fodder required for the cattle and leaf manure. Also grazing grounds for cattle.

(*e*) Several industrial products like gum, resins, pods of *shikekai*, honey, wax, dyes, leaves for *bidis*, leaves for paper, plates, etc.

(*f*) Several medicinal plants about which there is no reliable information at present.

In addition to the above, the Kanara Forests yield important minerals like manganese. For the better exploitation of these minor products the Government have recently appointed a Forest Utilization Officer.

The above is a rough outline of direct financial benefits which the Community derives by the systematic management of its forest wealth. But, besides these, there are tremendous (and from the national point of view far more important), benefits conferred on Man by the maintenance of these forests:

The conservation of soil, the maintenance of subsoil water-level, humidity and equitability of temperature in hot and cold seasons, are all affected by tree growth. The occurrence of floods in the rainy season and of drought in the non-rainy season are entirely dependent on the forest cover on the catchments of rivers and streams.

*THE DENUDED CONDITION OF THE MINOR FOREST IN KANARA COASTAL TRACT, ITS HISTORY AND A SCHEME FOR ITS REGENERATION

BY S. S. DHARESHWAR,

Range Forest Officer, Honavar, W. D. Kanara

Summary.—The strip of forest lying between the Kanara seaboard and the foot of the Western Ghauts or Sahyadris has been mostly constituted the minor forest and set apart for the exercise of the local privileges. The condition of the forest is much too deteriorated and the denudation has a history three or four centuries old. Teak appears to have grown after the denudation, that is, when the plant succession was thrown back and conditions favourable to deciduous species were created. Yet the evolution of plant growth is there as permitted by the physiographic conditions and the way in which the progressive succession is being established locally in the denuded areas is described. The local prejudices about teak have been set forth and the loss that may be caused to the nation on account of unreasonable restrictions on teak planting since imposed has been pointed out.

As a means to restock the area, regeneration of junglewood species, mostly useful for fodder under Taungya System, has been suggested. Fire protection rather than controlled fires as also controlled grazing as may be permitted by the local conditions have been advocated, provided the Rural Development Board takes interest in such activities and co-operates with the Forest Department in carrying out the scheme.

Foreword.—This paper is based chiefly on the field observations made by me during these four years in the Honavar Range. From what I have been able to note of the coastal tract of Kanara during my journeys up to Karwar in the north and Bhatkal and beyond in the south, I am of the opinion that the problem of the Honavar Taluka is analogous to that of the coastal tract which comprises the foothills of the Sahyadris, mainly classed as minor forests for the exercise of local privileges which are now controlled under the Collins Settlement. The area is much denuded of its useful tree growth.

Past History of Deforestation.—The causes that have led to the present denuded condition of the forests in this tract can be traced to history more than three centuries old, that is, from about the date of the downfall in 1565 of the mighty Vijayanagar Kingdom of which Kanara formed a part and was prosperous. On the disintegration of the empire, the feudatory chiefs rebelled and anarchical conditions prevailed. This tempted the Marathas and the

*This paper was read at the annual session of the Forest Rangers' Association, S. C., Bombay, held at Belgaum in October, 1940.

Deccan Sultans who vied with each other for supremacy in Kanara —which here means both north and south as at present constituted —as the district was famous for its trade in pepper, spices, sandalwood, coco and areca nuts, etc. The overlord of the district was now the Raja of Bednur, who had his seat of government in Bednur in the present Mysore territory. Under their great leader Shivaji, the Marathas committed frequent raids that devastated Kanara, especially the lowlands. One Dalvi was the local commandant under the Sultan of Bijapur whose rule in Kanara was just and sympathetic. But this Dalvi proved a traitor and helped Shivaji in his campaign of plunder and arson. A few more details of history may be permitted to be indulged in as they would be undoubtedly interesting as also revealing having a direct bearing on the subject under reference. In 1673 the well-known English traveller Fryer visited Kanara coast when the hills round about Honavar were already laid bare. In 1676 the same traveller experienced near Ankola "a lively portraiture of Hell, as the forest was on fire, apparently purposely burnt, because it had sheltered the rebel Dalvi" whom the people wanted to capture for his treachery. Shivaji burned the town of Karwar in 1675 as the garrison did not yield and Ankola in 1676. The result was that the people in this forest-clad tract of Kanara lowlands were so terror-stricken that they on their part began a ruthless onslaught on the forest round about and burned it and kept the country open in order to rid the area of the shelter that it could afford the plunderers and bandits. The hills alongside the Mirjan river had already been deforested as observed by Fryer in 1676. The country was thus laid waste, the hills denuded and population decreased. In 1720 the northern part of Kanara lowlands beyond Mirjan river was ceded to the Marathas by the Court of Delhi. And yet the Maratha hordes maintained their tradition of predatory incursions. In 1726-27 Peshwa Baji Rao's raids in Kanara were devastating. Plunder, blackmail and arson were rampant. The tyrannical conduct of the Rani of Bednur and the disordered state of her territory opened the way to its conquest by Haider Ali in 1763. He sacked Bednur which was so far immune from invasion and carried away riches calculated to be worth 12 million pounds. The whole of Kanara now came under the sway of Haider Ali and continued to be held by his son Tipu Sultan. Even during this period, the

Marathas were persistent in their raids, so much so that they sacked the great Hindu monastery (*math*) at Sringeri and the Swami had to take refuge under Tipu Sultan whose relations with him were cordial. Tipu restored his possessions to the Swami and made further amends for his losses. The respectful and sympathetic message that he sent on this occasion to the Swami denouncing the deeds of the Maratha freebooters unveils the nature of the much maligned Tipu Sultan of Mysore.*

To sum up, the latter half of the 18th Century found Kanara in a veritable cauldron seething with trials and tribulations. The country was overrun by bandits and warring chiefs. Moral and political weakness had reached the lowest point. On the overthrow of Tipu Sultan in 1799, the whole district of Kanara passed to the British. Captain Munro—later Sir Thomas Munro—was the first Collector of Kanara during 1799-1800. He then found that the land had ceased to be economic and was lying waste. The population was thinned down to a third. Famine, fever and pestilence overran the district. The description given of the malaria-stricken is indeed graphic. The cattle were dwarfed and famished. Even seaborne trade was not safe owing to the mischief of the Maratha pirates. Dr. Buchanan in 1801 observed that the hills were denuded between Bhatkal and Bailur—the barest tract he had ever seen. Munro drove the gangs of bandits out of Kanara and the first gift of English administration here was internal security or freedom from invasion and peace in general.

The above historical account answers the three main present-day charges levelled against the Forest Department that its policy has been the cause of (1) decrease of population, (2) impoverishment of the people and (3) incidence of malaria consequent on fire-protection resulting in the decline of agriculture, whereas all these economic cankers were already there infesting the legacy that was handed down to the British in 1800. Malaria was there—of course without its present nomenclature—in its worst form a century prior to the organization of the Forest Department. The conditions, however, gradually improved as a result of secure and stable government leading to the steady

* This account of the sack of Sringeri was published by a researcher in history in the *Times of India* some two years ago.

betterment of the people which can only be perceived by the unbiased. No doubt, there has been some further decrease in the population and in the cultivated area during the closing decades of the past century, but their causes are to be sought elsewhere. There were plague, famine and pestilence and migration to industrial centres as agriculture could not pay owing to the changed world conditions. In regard to the control on our forest, the indiscriminate deforestation was put a stop to and only *kumri* cultivation was permitted. In 1848, however, orders were issued prohibiting forest clearings within nine miles of the sea and three miles of large rivers, reserving certain trees. Kumri was thus gradually reduced. In 1860 clearings of all kinds were forbidden. After the transfer of the district to Bombay in 1862 this rule was relaxed and clearing was again allowed to a limited extent and it was then permanently stopped in 1897 after the Forest Settlement. The popular demand for the extension of the minor forest was, however, met again by the Revised Settlement done by Mr. Collins, I.C.S., in 1921, which has been found to work very satisfactorily.

Description of the Tract.—This much about the history of denudation. It will, however, be interesting to observe how Nature always tries to maintain the balance between its constructive and destructive forces unless effectively upset by meddlesome man. These denuded hills in the lowlands evidently covered originally by semi-evergreen forest began slowly to recuperate but under altered conditions which promoted the growth of deciduous species. This accounts for the sporadic occurrence of teak in congenial localities and the species must have appeared some 200 years ago. This idea has been supported by the ring-counting done of teak trees felled in a current coupe in the Balemet Valley in which the thickest teak, 12 feet in girth, is found to be 200 years old. A number of them range from 95 to 150 years in age and 5 to 7½ feet in girth. Yet the local climatic conditions have been there to assert themselves in evolving the forest growth and thus we find again in parts of reserved forest not much disturbed by human interference a preclimax formation which has overwhelmed the sporadic patches of teak depriving them of any scope for reproduction. The rainfall is heavy, ranging from 125 to 175 inches and perhaps more in the interior. The soil is chiefly

lateritic and subject to leaching which is so thorough that the soil alkalies and silica are washed down, leaving oxides of iron and alumina. In places where the stratum is permeable they are taken down and deposited in the lower layers and thus we find the fine white or reddish clay deposits below the laterite.

The hilly configuration and further deterioration of an already impoverished minor forest brought about by indiscriminate hacking by the privilege holders, overgrazing and constant fires, lead to heavy soil erosion during the monsoon. The soil is thereby impoverished and compacted, tending to the reduction of the subsoil water supply which is the source of perennial springs that irrigate the gardens. The exposed laterite sheet rocks on the hilltops and the boulders on the slopes speak eloquently of the intensity of the soil erosion that has been going on practically unchecked for centuries. The eroded soil is deposited in the hollows and on gentler slopes where occurs either some plant cover or grass growth that helps control the runoff to some extent. Such favoured spots having overlying soil stratum are found occupied invariably by tree growth whose quality varies in accordance with the depth of the stratum. (See Plate 3, fig. 1.)

Effects of Erosion.—The eroded forest soil is so much impoverished that it yields but a very poor quality of grass which again is overgrazed. The reserved forest beyond the minor rarely provides any grazing. The cattle brought up under these conditions have been poor specimens. Better breeds introduced from outside do not thrive for obvious reasons. The narrow strips of cultivation at the foot of the hills do not fare better either. The soil runoff from the denuded hills carries with it precipitates such as clay released from the laterite strata which clog the soil pores in the fields below. They thus slowly lose their fertility consequent on water-logging and want of soil aeration. The cultivator who seems to be oblivious of the disastrous result seeks elsewhere for its cause and never fails to attribute it to the presence of teak should it occur in the vicinity.

Incidentally, a few words in vindication of teak would not be out of place. It is said to be the general belief in the Kanara coastal tract that teak growing in the vicinity of the cultivation is harmful to the crop which is mainly rice. Nothing could be more fallacious than this idea which is possibly the outcome of the envious popular

Fig. (1)

A part of minor forest area denuded of tree-growth. The extruded rocks and boulders show the extent of soil erosion going on in the area. The cross in the foreground shows the beds of vegetables raised in the monsoon in the arable parts on the lower slope.

Fig. (2)

A view of bare and stony slope in a part of minor forest since owned by Mr. B. M. Basrur of Honavar and planted up with *matti, kindal, honni, jamun, cashew, avla* and *sandal* in the hedge. Age 18 years, height 35 feet and 18 inches g.b.h. In better soil in similar areas, the height in 20 years is 45 feet and 27 inches g.b.h

outlook on teak—an all-round and very valuable reserved species. The chief agricultural produce of Kanara, as is well known, is rice. And the best rice-growing tract in the district is involved in the teak pole area comprehending the eastern parts of Haliyal Taluka and Mundgod Petha. The adjacent rice-growing tract of Dharwar, Kalghatgi, Bankapur and Hangal Talukas too have more or less similar forest conditions. In all these areas the rice cultivations stretch out into the forest and in places are even surrounded by it. In the Kanara teak pole area, the percentage of teak may vary between 25 to 60 per cent. One out of several such instances is the old Block VII-A of Haliyal Range bordering on the extensive rice-belt to the west of Haliyal—Alnavar Road. Yet the rice cultivation receiving much of the drainage from this block thrives well and the *raiyats* have never been found to look upon teak as a curse. Far from having a deleterious effect on soil fertility, teak maintains soil porosity and, therefore, tends to promote soil aeration. Its crisp leaves are oxidised sooner than any other leaf litter which is invariably leathery and they get easily assimilated with the otherwise compacted soil underneath, improving its texture and facilitating capillarity. The advantages thus afforded by teak can hardly be overlooked by either the forester or the cultivator. It is Nature's own plan of adjustment that evolves the species suited to a locality for its soil maintenance and man should be grateful to Mother Nature for the presence of such species as teak, *avla*, etc., having peculiar foliage that decays rapidly even under poor humic conditions. The usual absence of plant growth under the teak is pointed out as indicating the harmful conditions fostered by it. This again is equally delusive. The phenomenon is not due, at all events, to any noxious elements liberated from teak leaves. As a matter of fact, shady conditions maintained by any tree having a dense crown suppress the vegetation below. In the case of teak, Karmal and the like, however, the effect is more thorough because of the severe drip from the crown of broad leaves. The next objection advanced in respect of teak is that its leaves do not yield good litter or *soppu* which the agriculturists greatly need for manuring purposes and that, therefore, the gradual conversion of the accessible forest into a teak-bearing area here may deprive the people of their mainstay of agriculture. This apprehension is again groundless, inasmuch as within about 10 years' age, the

teak plantations in these parts give full scope to junglewoods which constituted the original stand to gradually appear below as an understorey and such a mixed stand, on further treatment of the plantations, would yield but an ideal leaf-litter having a lean mixture of teak leaves that would only accelerate the process of manurial decay. The so-called local prejudice notwithstanding, it is a familiar sight here to find teak grown by the owners alongside their private holdings. I know recent instances in which some of the prominent landowners have been trying to introduce teak in their lands. Nevertheless, it is anathema the moment it is planted by the Forest Department even beyond one furlong from the cultivation. It has thus been now relegated a place in the forest beyond one mile from the habitation although instances are not wanting in which villages having more than 10 houses each unanimously urge that the prohibitive limit for teak planting may be reduced to two furlongs from a village instead of a mile. It may also be noted here that much of the inhabited and cultivated area in these parts is involved in the minor forest tract in which no teak planting is done by the Forest Department. Such departmental activities have been confined to the narrow strip of accessible reserved forest since organized, which stretches beyond the minor forest and up to the foot of the Western Ghats. Yet there has been the restriction which has unreasonably curtailed one of the most useful activities of the Forest Department of enriching the otherwise impoverished remote forest and for that matter enhancing the national income. Bias and self-deception cannot go further. Even as little as about 40 per cent. of mature teak in a coupe can conjure up the price five to six times the value which a junglewood stand can otherwise fetch here. It, therefore, behoves us, as the custodians of a natural asset, so to represent the matter in its real light that the Government be pleased to modify the orders passed some two years ago regarding restrictions on planting teak.

Scheme for Regeneration of Denuded Forest.—The denuded forest being ill-equipped to meet the wants of the people, there often is an outcry to extend the area further into the reserved forest. But that is no remedy for the evil. Its causes are set forth above and the cure lies in restoring the natural conditions of the locality as far

as possible. Thus the scheme for the regeneration of the minor forest as visualised is outlined below:

(*i*) *Restocking* of fodder and timber trees useful to the local agriculturists *by the agri-cum-forestry method*. The stretches of bare areas in the minor forest of varying extent including the old abandoned cultivation since afforested may be taken up for the purpose in instalments without curtailing the grazing requirements of a village. A unit of say 10 acres or even less may be given out for Taungya to willing villagers on condition that the work be conducted according to the terms of the agreement and the guidance of the Forest authorities. More than one such unit may be taken up in a village simultaneously should conditions permit doing so. The terms proposed are:

(*a*) The group of cultivators or lessees for that matter to enclose the area under regeneration at their own cost with a strong hedge for which Pangara, Agasti, Dasal and such other hedge plants useful for fodder be used, implemented by thorns and maintained in good condition until the termination of the lease. Bamboo (*Dendrocalamus strictus*) which has also fodder value can be introduced in the hedge running alongside a boundary ravine.

(*b*) The seed and plants to be introduced be supplied by the Forest Department free of cost.

(*c*) The espacement for planting to be 18 by 18 feet and no crop should extend within a three-foot radius of a plant.

(*d*) The plants to be kept weeded and mulched as and when required.

(*e*) Stony areas unfit for field crops that may be included in a unit of the Taungya to be sown with seeds of grass and suitable herbage by the cultivators collectively.

(*f*) The time-limit for the lease of a unit to be eight to 10 years which, in other words, is the period of closure, to be sanctioned by the collector. A shorter period is not advised as the plant growth would thereby not be big enough to withstand damage by cattle.

(*g*) The area to be fully stocked by the end of the first season and casualties filled up as and when they occur so that the area when relinquished may have all the plants established at the given spacing.

(*h*) The area to be effectively fire-protected during the currency of the lease.

(*i*) Taungya on steep slopes to be contour-trenched in order to control the soil runoff.

(*j*) In return whereof, the lessees to have the privilege annually to raise crops of *ragi, vari* or *savi* chillies and other vegetables for their use *free of any assessment.* No burning of the area will be permitted from the second year and up to he time the lease expires.

(*k*) The penalty for default, that is when any or all of them drop out, to be up to Rs. 50 liable to be paid by the lessees either jointly or severally as the case may warrant in addition to an assessment at the rate of annas four per acre per annum for the period of actual tenure.

The species recommended for propagation in the Taungya are *bethonne, phanas,* mango, cashew, *bhirand, anjan,* sissoo, *tadsal, karmal, mulhonne, antal, apta, atti, jamun, kindal, Pithecolobium saman* and *matti,* etc., according as the soil conditions permit. *Matti* is given the last place in spite of its adaptability and fodder value because it is very much subject to stripping of bark by fishermen and chamars and their agents and their depredations scarcely permit the species to thrive even in well-guarded private holdings. Yet it is hoped that this system of cultivation, when introduced, would help inculcating the value of collective responsibility and co-operative work on the otherwise self-centred and improvident villagers. This is why individual assignments are not advisable in order to achieve the object in view because, far from being beneficial to the villagers at large, they tend to perpetuate the idea of exclusiveness among the holders. It is this exclusiveness that has made the people rather indifferent towards their environment and the scheme as has been proposed above would tend to promote community of interest and love and respect for the forest.

The only thinning suggested is in the 15th year or as may be indicated by the conditions of growth after which the spacing would be 36 by 36 feet which would be final.

The measures as proposed under (*e*) above may need some elaboration. Stony areas with poor soil included in a unit may not be willingly shared individually by the cultivators. Hence the recommendation to attempt restocking such patches with a collective effort. The only soil cover that can be expected in such places is poor quality grass. This can be improved by the introduction of Hookarad (*Andropogon monticola*). One of the foremost plant species to colonise the bare area closely on the heels of grass as has been observed here is *ukshi* (*Calycopteris floribunda*) which is admirably adaped to thrive in varying edaphic conditions. It is a fire-resister. Given optimum conditions, this species grows into a gigantic climber—which it really is—and ascends even stately trees in evergreen forest. But in the bare stony soil it looks as meek as its associates of the order *Gramineæ* and submits to constant lopping for green manure and thus does not grow beyond the bushy stage. The controlled shrubby growth of this climber serves as a check against soil erosion to a considerable extent. It is of prime importance, therefore, to disseminate the seed of this species extensively in such areas. The further progression is indicated by such of the lower types of the order *Rubiaceæ* as *kari* (*Canthium parviflorum*), *patkal* (*Ixora coccinea*), *Zizyphus* species, *kavli* (*Carissa Carandas*), *maddarasa* (*Tabernaemontana Heyneana*) of the order *Apocynaceæ*, *mulgojjal* (*Bridelia retusa*), *phatarphani* (*Bridelia stipularis*), *avla* (*Phyllanthus Emblica*), etc., of the order *Euphorbiaceæ* of which the corky barked *kurudnanaka* (*Sapium insigne*) preponderates. This type, however, culminates in the growth of *khair* (*Acacia Catechu*) which is so common in the laterite scrub forest. The following species which help increase the humus contents of the soil now enter into the composition of the next stage, of course diminishing *khair*. There are: *kumbia* (*Careya arborea*), *karmal* (*Dillenia pentagyna*) an occasional *heddi* (*Adina cordifolia*), Bombax, Gojjal (*Odina Wodier*), Char (*Buchanania latifolia*), *apta*, *siras*, *honni* and *terminalias*. The ground cover by now is of a higher type consisting of shade-bearing herbage that helps conservation of soil moisture as

represented by *musalkombu* (*Elephantopus scaber*) and other plants of the order *Compositeæ*. *Butea frondosa* either does not occur or is very rare as it chiefly thrives on saline and heavy soils to which the local physiographic conditions do not lend countenance. *Kasga* (*Strychnos nux-vomica*) which is subject to mutilation for green manure cannot be included in the stage described above, it being probably a relic of the preceding formation and now suffered to stand on account of its being a reserved species. It reproduces freely and thus implements the progression.

The above account shews how bare and stony areas can be made to evolve a scrub formation and set well on the path of progressive succession. (See Plate 3, Fig. 2.)

(*ii*) *Controlled Grazing*.—Success in regeneration can hardly be possible without controlled grazing. There are, however, inherent difficulties in the way of introducing any elaborate scheme of control. Unlike upland Kanara, there are no *gaothans* or village sites here and the houses in a village have been usually scattered in individual holdings mostly adjacent to the forest. Herding of cattle for the purpose of pasturing is rarely, if ever, effectively practised and that too for a short time that the fields bear the crop. As regards the pasturage again, it is not available easily and in plenty owing to the causes already explained. This is why there was a strong popular protest when Government proposed the revised draft grazing rules. To a *raiyat* here every head of cattle that he possesses is an essential one. He is thus loth to discriminate some as against the rest. Then again, there is the difficulty of allocation of the available areas as ranches and regular pastures. The people, therefore, never took kindly to the proposals.

Nevertheless, it appears that it would be possible to evolve a simple form of rotational grazing as can be arranged by the villagers or a group of villages on close examination of the conditions applicable in each case through the agency of the Rural Development Committees and in consultation with and controlled by the Forest Department. Such a scheme may then be accorded the legal sanction that it may require for its introduction. The people do realise the importance of controlled grazing and the success in introducing it lies mainly in the simplicity of the plan. When they are once

accustomed to the control, the rested areas can be sown broadcast with seeds of useful grasses and herbage. Stall-feeding can also be practised as the people are convinced of the benefits accruing to them from such activities as have been recommended above.

(*iii*) *Fire Protection*.—The villagers are now permitted to burn the area of minor forest every year in April and May "to promote better growth of grass." But it may be debatable still whether regular annual fires in a hilly tract almost denuded and having a heavy rainfall would really help the object in view. In order to promote good growth of grass a certain amount of acidic condition in the soil has to be maintained. And this can best be done here by way of fire protection or controlled fires. The apprehension is that without a judicious control, the villagers may abuse the privilege. The pastures should not be burnt before cutting the grass and the burst of early showers in April or May, so that the fires be superficial, consuming only the stubble. Heavy fires render the soil friable and in the monsoon the thin top crust which shares much of the fertility is also washed down the slopes into the ravines below. It is said that the runoff from a completely denuded area is 20 times greater than it is from a thickly wooded area. The changed soil factors encourage a type of vegetation usually poorer in quality than the preceding one. On the other hand, fires would certainly reduce the soil acidity and/or alkalinity as may exist and thus improve the quality of grass in the ill-drained flat areas or gentler slopes in the *forests of Kanara uplands* which are in places overrun by thick, coarse grass as ground cover.

It may, therefore, be emphasised that in the denuded parts of the coastal tract having its own climatic peculiarities, protection from fire or controlled fires after early showers rather than regular annual burning may help the establishment of grass culms and the gradual extension of the pasture.

In conclusion, the success of the scheme for the regeneration of the minor forests as visualised would depend upon how the people are helped and encouraged in the work. Success in agriculture is dependent upon the conservation of the village forest to its optimum condition and in their effort in this direction the villagers may well be guided by the Rural Development Board which may take up the matter in hand in all seriousness, in collaboration with the Forest

Department. Bands of selfless village workers should go to the countryside and help and infuse a spirit of progress into the ignorant people. Even such items of work as the sanitation of the villager's premises should find scope in their demonstrations, so that the villager be moved to shake off his passivity and fatalism and gain instead a sense of the right perception of the means of his own advancement and, for that matter, of the community and the nation.

BOTANICAL NAMES OF THE SPECIES MENTIONED IN THE NOTE.

AGASTI	...	*Sesbania grandiflora.*
ANJAN	...	*Hardwickia binata.*
APTA	...	*Bauhinia racemosa.*
ANTAL	...	*Sapindus trifoliatus.*
ATTI	...	*Ficus glomerata.*
BETHONNE OR HONNI	...	*Pterocarpus marsupium.*
BHIRAND	...	*Garcinia indica.*
CASHEW	...	*Anacardium occidentale.*
DASAL	...	*Hibiscus species.*
JAMUN	...	*Eugenia jambolana.*
KARMAL	...	*Dillenia pentagyna.*
KINDAL	...	*Terminalia paniculata.*
MANGO	...	*Mangifera indica.*
MATTI	...	*Terminalia tomentosa.*
MULHONNE OR MULGOJJAL	...	*Bridelia retusa.*
NIM	...	*Azadirachta indica.*
PANGARA OR HANGARAKA	...	*Erythrina indica.*
PHANAS OR HALASU	...	*Artocarpus integrifolia.*
RAGI	...	*Eleusine coracana.*
SIRAS	...	*Albizzia Lebbek.*
SISSOO	...	*Dalbergia sissoo.*
TADSAL OR DHAMNI	...	*Grewia tiliaefolia.*
VARI OR SAVI	...	*Setaria italica.*

BIBLIOGRAPHY

India through the Ages. By Sir J. N. Sircar.

The Main Currents of Maratha History. By R. B. G. S. Sardesai.

The History of Mediaeval India. By C. V. Vaidya.

The Kanara Gazetteer. Vols. I and II.

Manual of Indian Silviculture. By H. G. Champion and Sir G. Trevor.

The Silviculture of Indian Trees. By R. S. Troup.

A Handbook of Practical Geology. By M. B. Pithawala.

An Introduction to Scientific Study of Soil. By N. M. Comber.

The Nature and Properties of Soil. By Lyon and Buckman.

The Conservation of Punjab Water Supplies. By R. Maclagan Gorrie, D.SC., published in the *Indian Forester* for November, 1938.

Honavar Range and Teak Regeneration. By S. S. Dhareshwar, published in the *Indian Forester* for July, 1939 and June, 1940.

REVIEWS AND ABSTRACTS

MANUAL OF INDIAN FOREST UTILISATION

BY H. TROTTER, I.F.S.

The publication of a manual on a major forestry subject such as Utilisation is an event of considerable interest to forest officers. Troup's *Indian Forest Utilisation* was published in 1907 and the second edition came out in 1912. Since that date no other general textbook on Indian Forest Utilisation has been published.

The publication of this new *Manual of Indian Forest Utilisation* is, therefore, a very welcome addition to India's forest literature. It was actually written and ready for the press several years ago, but its printing was held up pending the publication of Trevor's and Champion's *Manual of Silviculture*. The new Manual is, therefore, not so up to date as it might be, but it is nevertheless a very useful book of instruction for forest colleges and will also prove of interest and value to forest officers.

In the main, it follows the recognised lines of utilisation textbooks. Part I deals with the anatomical structure and properties of wood and has chapters on felling, conversion, transport, storage and the disposal and sale of wood. There is also a very useful chapter on the uses of wood which will be of interest to all timber users.

Part II contains three separate chapters on important auxiliary utilisation subjects, namely, seasoning, wood preservation and saw mills and wood workshops.

Part III covers the subject of minor forest products very comprehensively, and Part IV has separate chapters on lac, resin tapping, charcoal, pulp and paper-making, grazing and grass-cutting.

At the end of the book there is a most useful key for the identification of Indian timbers, and several appendices showing specimen marking registers, sale notices, forms of contracts and specifications of sleepers used in India.

There are nine diagrams and 18 other illustrations, mostly photographs.

The author, who is well known to most forest officers in India as the Utilisation Officer at the Forest Research Institute, explains in a short Preface that the Manual was intended primarily as a text

book for Indian Forest Ranger students and does not aim at being a comprehensive or complete Manual on all aspects of Indian forest utilisation. At the same time, he explains that such subjects as kiln-seasoning, timber testing, wood technology and wood preservation were almost unknown in India when Troup's Manual was revised in 1912, whereas they are now amongst the most important branches of modern timber utilisation. For this reason the author expresses the opinion that the new Manual will prove of interest to most forest officers in India, since it contains a lot of information which has not been published before.

We can with confidence endorse the author's opinion, and we feel sure that this new Manual will be of extreme interest not only to all forest officers in India, but also to a large number of timber users in India, including Government Departments and private firms. The Manual is very well printed, and is published by the Oxford University Press, from whom copies can be ordered. The price is Rs. 20, but the President, Forest Research Institute, has a stock of copies for sale to Forest Colleges and students at Rs. 11-4-0 per copy.

EXTRACTS

BIHAR'S FOREST WEALTH

PROVINCIAL FOREST UTILISATION BOARD MEETING

Problems connected with the better utilisation of Bihar's forest wealth were discussed at the first meeting of the Provincial Utilisation Board recently held at Ranchi. Mr. E. R. J. R. Cousins, I.C.S., Adviser to the Governor, presided.

In his opening address Mr. Cousins said that the Forest Research Institute, Dehra Dun, had done much valuable work in testing the possibilities of timber and other forest products. In order to bring the industry and forests in closer touch, the Government of India had constituted a Central Advisory Board on Forest Utilisation which had already met to consider the work done and to be done for the better utilisation of India's forest wealth. The recommendations and resolutions of that meeting were now before the Board to consider in the light of

their provincial utility. It was important to remember that the Forest Research Institute was essentially a central bureau of scientific investigation and the material with which it functioned depended to a very considerable extent on provincial problems and supplies for the management of the forest areas were largely the concern of the local Government. It was, therefore, necessary to review, in the light of the functions given to this Board, not only the nature of work achieved at this Institute but the extent to which it could be applied with benefit in the management of our forests and the extent to which such information was passed on to the all-important suppliers in the forest and the various consumers in the different trades. Lastly, to give careful consideration to the local problems that still required the necessary scientific investigation and which would have to be left to the Forest Research Institute to fulfil as such work was highly technical and expensive and beyond the means and scope of the provincial forest organisation.

In view of the diverse nature of the work on hand and the very limited time at the disposal of the Board the Chairman then convened two Committees, assisted by the Conservator of Forests and the Forest Research Officer to furnish recommendations for the Board's consideration.

The Conservator of Forests then gave a detailed account of many problems that still restricted the fuller development of local forest utilisation, stressing in particular the need for cheaper and better communications, facilities for the exploitation of seasoned manufactured produce, more intimate contact with the traders in general, and the greater use of the medium of propaganda.

This first meeting concluded with the adoption by the Board of nearly all the resolutions put forward by the Committee.

Forest Exhibition.—An interesting adjunct to this meeting was a display of exhibits by the Forest Department representing many of the activities of its current management and welfare. These varied from the simple village products of bamboo bows and wooden ploughs to such complex articles of the forest produce as paper, veneers and chemical distillates. There were also exhibits and models to show some of the difficulties and dangers modern forest

management has to face from insect and fungal incidence. But one of the most interesting and illuminating exhibits was a wooden erosion model to demonstrate the comparative effects of the runoff of rainwater from slopes adequately covered by a forest belt and those denued by the excessive wielding of the man-made axe. The topographical nature of the province is such that its forest policy not only affects the local inhabitants but the welfare of millions who live by the soil.—*The Searchlight,* November 10, 1940.

THE FIG IN RURAL AREAS

By Captain W. Sherrard Smith, M.C.

Introduction.—The possibilities of the fig in rural areas have not been fully explored. The reason for its slow penetration into these parts is largely due to the fact that the tree requires an annual pruning. A tree left to the whims of Nature will soon become unproductive or bear fruit of no commercial value.

With the formation of the Rural Development Department and the Fruit Development Board, assisted by the resources of the Gardens Department, this drawback should be easily overcome.

Another reason for its unpopularity is no doubt due to the fact that there are many varieties which, though they bear fruit, never ripen, or if they do they are of inferior quality. Here again it is a matter of introducing the right kinds.

In the Government Gardens at Lucknow there is a variety called Black Ischia. The fruit when ripe assumes a purple colour, is luscious and grows to the size of an egg. A single tree fetches about Rs. 5. Considering the space it occupies, the return is excellent.

For village planting it is one of the most suitable fruit trees for planting in closed-in areas. During the winter months it is devoid of all leaf which permits the maximum amount of sun to penetrate these enclosures—a very desirable feature.

History.—The fig is grown extensively in the Mediterranean and in Turkey and we are all familiar with the dried produce strung together on short pieces of grass string which comes into the market from these parts during the winter season.

The fruit is also grown in Afghanistan and the dried fruit from these parts also comes into the market during the same period. This fruit is not as large as the other foreign produce, but is sweeter and for this reason is largely preferred.

It is not, however, for the purpose of drying the fruit that it is recommended for cultivation in rural areas. There is no doubt that the dried fruit is greatly relished, but it can stand no comparison with the lusciousness of, or the benefits to be derived from, the fresh fruit.

Here in the United Provinces the tree is found thriving vigorously throughout the plains and up to 4,000 or 5,000 feet in the hill districts.

Description.—Botanically it is known as *Ficus Carica* while in the language of the Province it is called *unjeer*. It belongs to the *Urticaceae* family. The *peepal, bargad, goolar* and *pakar* all belong to the same family.

It demands very little attention, except for an annual pruning of its branches. During the months of November to February it is deciduous. As soon as the warm weather sets in, the tree breaks into leaf, at the same time producing fruit buds which later set fruit abundantly.

The fruit begins to ripen in April and from this time till the end of June ripe fruits are harvested. As soon as the rains set in the fruit ceases to ripen and those that remain turn yellow and drop off.

A second crop of fruit is produced during the rainy season but they never ripen and are quite useless.

Varieties.—In addition to the variety previously described the following are said to be successful in Saharanpur but are apparently not much sought after:

Fig Cabul.
Fig Bangalore.
Fig Lucknow.
Fig Brown Turkey.

Soil, Water and Manure.—Though found growing throughout the Province, the tree will not grow to perfection in sandy soil. It prefers a tenacious clayey soil provided there is sub-soil drainage. In soils such as this it will bear the best crops.

Nevertheless, its cultivation on sandy soil is not to be rejected. Provided it is encouraged with an annual mulch of any organic manure, such as kitchen sweeping, animal droppings or vegetable mould made from weeds, leaves, etc., the tree will respond and produce a fairly heavy crop of fruit.

It will not, however, succeed on low-lying water-logged soil and such situations should be avoided.

As soon as the fruit has reached the size of a marble, the trees must be copiously watered twice a month from now onwards until the crop has been harvested. This is the only time water will be required in normal seasons.

Newly planted orchards will, of course, require more frequent watering until the trees are strong enough to do without artificial watering.

Propagation.—The fig is probably one of the easiest trees to raise from cuttings and it is quickly and easily multiplied by this means. *Gooti* is, however, preferable. By this method sturdy plants can be raised in a very short time and as these make very rapid growth, an orchard can be established quicker than when plants raised from cuttings are used.

All the growth that is taken off at pruning time can be used for cuttings. These are cut into lengths about 12 inches long and planted out in prepared beds one foot apart each way. This is done in December and plants are ready for planting out in the following July and August.

Propagation by *Gooti* is done during the months of July and August. A ring of bark about two inches wide is removed from the current year's growth and a mixture of clay and chopped straw is bound round the wound and kept in position by a piece of old *tat* or sacking. In a very short time roots will have filled the ball of earth, and the new plants may be severed and planted out right away in their new situations.

Plants not required for immediate planting may be potted singly into eight-inch pots, or they may be planted 18 inches apart each way in nursery beds. These plants can be safely removed and planted during the winter months.

Young trees three and four feet high can be raised by this method within a few weeks and the advantage of such plants when compared with those raised from cuttings is self-evident.

Planting.—Holes should be prepared in the dry weather (May-June). Plants raised by *Gooti* can be planted in these pits immediately they are cut away from the parent plant, i.e., by the end of August.

Planting may be deferred till the winter months if desired, and if the plants are to travel a long distance the better plan would be to plant at this time.

Plants raised from cuttings in December are ready for planting out in the following July.

In sandy soil the plants should be spaced out 15 feet apart, but in rich soil, where a vigorous growth is made, the distance may be increased to 18 or 20 feet apart.

Pruning.—This operation is absolutely necessary if the tree is to produce edible fruit which will ripen on the tree. A tree left unpruned will not do this.

It is imperative to train the tree low to the ground, causing it to assume a spreading habit.

With this object in view, pruning is necessary from the very first year of planting.

It will be assumed that the young tree just planted is single-stemmed. In December, when the plant is deciduous this should be cut back to a foot or 18 inches from the ground.

The following December three of the strongest branches should be selected and cut back to 10 or 12 inches from the main stem and shoots on what remains on these branches cut back to one or two eyes. All the other branches should be removed entirely.

The next December the same process should be renewed but this time six or seven branches should remain.

This formation, i.e., one centre stem with six or seven branches, will constitute the structure of the future tree.

Each year the season's growth on these branches should be cut back to the third or fourth eye.

Conclusion.—On the lower hills, trees of an indigenous variety are to be found thriving in all manner of places. The fruit is very

inferior and not fit to eat. Research work on "top-working" these varieties should prove profitable, provided the right varieties are used for the purpose.

The rains start earlier on the hills and for this reason plants "saddle-grafted," or raised by other methods of grafting on the indigenous stock, may prove effective. The indigenous variety ripens early and by using this stock a solution to the problem may be arrived at.

There are few fruit trees that succeed at these lower altitudes and the fig may yet prove a rich source of income for the people.

In many parts of the province are to be found trees of good commercial varieties growing vigorously but neglected. The reason for this neglect is due to the fact that the fruit produced is not worth harvesting, or that the fruit does not ripen. These facts themselves are really due to the neglect of the trees in the first instance. Pruning, not being understood, the trees have been left to Nature, resulting in these unprofitable trees.

As a twig is bent, the tree will grow, and this in spite of the fact that there is a Divinity that shapes our ends. So if we cut and clip we are able to force the tree to bend to our will.

Neglected trees should be severely cut back to four or five feet from the ground. The young shoots which will spring from these decapitated stems should be annually pruned. The treatment, though seemingly harsh, will produce the desired results.

SHELLAC AND SOME OF ITS USES IN PROTECTIVE COATINGS

[An address by William Howlett Gardner to the New York Paint and Varnish Production Club, October* 13, 1938.]

Shellac is the only resin which is manufactured from a raw material produced directly by insects (1). It possesses, therefore, a certain peculiar combination of properties which cannot be duplicated by other materials.

---

*Research Professor of Chemical Engineering, and Supervisor of Shellac Investigations, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Chemical Composition.—It is not a chemical entity, but a solid solution of several different compounds. No single formula (2) (3) therefore gives even a fair approximation of its properties. Dr. Schaeffer and the author (4) showed that it could be divided into several component parts by subsequent extractions with organic solvents which dissolve definite portions of the resin. Dr. Weinberger was able in this manner to separate shellac into a number of fractions which contained either a single component or a simple mixture of like components. (5) These fractions were devoid of film-forming characteristics in contrast to those of the original material.

The harder portion of the resin, termed by Drs. Harries and Nagel the "reinharz" (6), was divided into four fractions. Two of these we have studied in detail.

The largest fraction appears to be composed of a mono-basic inter-ester-acid, $C_{32}H_{54}O_9$ from which was obtained equal molecular proportions of aleuritic acid, $C_{15}H_{28}(OH)_3$ COOH and a mixture of isomeric acids (7) having the properties of a compound with the formula $C_{14}H_{22}$ (OH)(COO)COOH which was called lacollic lactone. Table I lists the chemical constants calculated for an inter-ester such as might be produced from these two acids. These are compared with those found for this fraction which comprises 40 per cent. of resin.

The second largest fraction, comprising 20 per cent. of pure lac, appeared also to contain a single type of component. In this instance, it can be represented as an inter-ester of aleuritic acid, the above lactone-acid, $C_{16}H_{24}O_5$ and the previously unreported kerrolic acid, $C_{15}H_{27}(OH)_4$COOH. This fraction, unlike the first, was very susceptible to partial saponification by dilute solutions of alkali, indicating that the inter-ester contained a lactone group.

The two uninvestigated fractions of the hard portion appear to be composed of similar inter-esters of hydroxy-acids of higher molecular weights. These two fractions comprise but 20 per cent. of the resin.

The rest of the shellac resin has a semi-liquid consistency which we were able to divide into two distinct fractions. One contained only a mixture of monomeric hydroxy-acids of which aleuritic acid and the lactone-acid mixture were found in the largest proportions. The other fractions contained both monomeric aleuritic acid and

simple condensates of aleuritic acid, the lactone-acids and an isomer of aleuritic acid. These fractions serve as a natural plasticizer to the harder portions and contribute to the high gloss exhibited by this resin. They also contain a large amount of the natural dye-stuff, erythrolaccin and associated material. It is this dye which imparts the golden yellow or orange colour to shellac. It is probably converted to a colourless chlorinated derivative when lac is bleached with sodium hypochlorite (8).

Shellac Research.—These investigations and the others which will be described formed part of a large international programme for the study of shellac. They serve as an excellent example of what can be accomplished in a surprisingly short period of time through close co-operation between different laboratories even when widely separated. The work in this country was carried out by the Shellac Research Bureau of the Polytechnic Institute of Brooklyn, which is sponsored by United States Shellac Importers Association, and the Indian Lac Cess Committee. The other studies were made in the laboratories of the Indian Lac Research Institute in Namkum, India, and in those of the London Shellac Research Bureau in Great Britain. Both of these institutes are supported by the above statutory committee established by the Indian Government.

The results from the studies of the chemical constitution of lac have been invaluable in suggesting means for improving the uses of shellac and for modifying its properties in adapting it to new uses. The resultant investigations have followed one or more of four types of general procedures; namely, incorporating other substances with lac, removing certain constituents from lac, chemically modifying shellac, and isolating various acids from lac for use as new raw materials.

Shellac Varnish.—Shellac has an unusual resilience, scratch hardness and a very high gloss, which contributes to its great value as a rapid-drying finish, but it shows considerable brittleness and a general lack of toughness when compared to some other coatings. The disadvantages can be corrected in part or completely by the addition of a suitable plasticizer. This plasticizer must be the type of compound which contains a considerable percentage of oxygen for compatibility. It should be composed of fairly large chain molecules to

complement those of shellac in building up a more flexible and tougher film. Dr. Bruins has shown that cellulose derivatives in small amounts, for example, can be employed for practical purposes as plasticizers for shellac as well as other types having these characteristics. When added in amounts from 10 to 20 per cent., the films in no manner resemble those generally classified as cellulose derivative coatings.

Water-resistant varnishes can be prepared by incorporating the plasticizer with French varnishes which have been specially clarified to remove all traces of wax and other insoluble material. This may be done by the use of the proper amount (3 per cent.) of filter-aid in an industrial filtration of the French varnish. These varnishes are clearer and more attractive than ordinary shellac films and show much greater wear and weather resistance. Dr. Bruins has had films of these varnishes prepared from orange shellac withstand several months of outdoor exposure while films from regular shellac under the same conditions disintegrated in less than two weeks. This was one of the most interesting of our studies for we learned a great deal at the same time with regard to the structure of varnish films. It was this problem which led us to undertake our preliminary studies of moisture adsorption and permeability which Mr. Payne has already described. (9) (10).

The properties of shellac films can also be greatly improved by baking. This is a fact which is sometimes overlooked in applications of shellac varnish where such a method would be perfectly feasible. When shellac is heated, it polymerizes, and evolves water, which would indicate that the relatively low molecular weight inter-esters found in this resin condense to form larger and more complex molecules. The polymerization may be divided into three stages, as is the case with the phenolic and urea resins (11). The characteristics of polymerized lac are intermediate between those of thermoplastic resins and those of the heat-hardened thermosetting types.

Another feature which is often overlooked in the industrial application of shellac varnish is spraying. Very excellent results can be obtained if the proper pressures and equipment are employed (12), otherwise, the operation resembles one of hosing. The possibilities for spraying molten, atomized lac, as is done in the case of

some metals, is being studied at the present time (13). It may prove possible that a polymerized coating of lac can be obtained directly by this method.

One group of manufacturers who have used large quantities of shellac varnish for a number of years is the electrical industries group. It is rather surprising to find how little is actually known regarding the true electrical properties of shellac. Considerable difficulties were encountered in undertaking our studies in preparing suitable test specimens (14). Occluded moisture and retained solvent had a marked effect in lowering the insulating properties (15). Some very peculiar effects were observed by Dr. Ackerlind at very low humidities, which would indicate that shellac may be polymerized even at room temperatures under these conditions. These measurements have given us a new tool for studying the behaviour of this resin and the physical structure of varnish films. A maximum dielectric strength is obtained with films of 0.005 inch thickness when they are dried under ordinary conditions (16).

Hard Lac.—Certain properties of lac can be greatly improved by removing the softer fractions of the resin (17). This was accomplished by Drs. Bhattacharya, Verman and Gidvani in Great Britain by selective solvent extraction and by treating lac with aqueous solutions of certain alkali salts (18-19). Varnish films of the resulting lacs were less liable to blush or whiten when placed in contact with water, and could be baked without the formation of bubbles and pinholes, unlike ordinary lac films. The softening and melting points of the hard lac were 7° C. and 10° C. higher than the original lac when 20 per cent. of the soft resin was removed. Scratch hardness of the unbaked films was increased several fold and adhesion improved by these processes.

There are some advantages to leaving part of the soft resin in the lac since it acts as a natural plasticizer. It was found that unbaked films on metals made by extraction with toluene and with trichlorethylene which removed most of the soft resin failed after six months of developing cracks and flaking. Limited removal of the soft resin can be accomplished using aqueous solutions of borax, soda, or ammonium phosphate. The greening of copper by lac can be eliminated by removing about 3 per cent. of the soft resin fraction, which has an acid number of 141.

Hard lac made by solvent extraction showed a tendency to lose its solubility in alcohol after being bleached with sodium hypochlorite solutions. The resin prepared by the aqueous methods did not exhibit these difficulties. Bleached hard lac can be prepared with an acid number of 55-65, whereas ordinary bleached lac has an acid number of 90-100.

It is not claimed that materials produced by these processes are better suited than ordinary lac for all applications but these investigations show that some of the possibilities lie in producing new lacs for specific uses. Hard lac is now produced commercially by both processes abroad.

Shellac Esters in Lacquer.—New resins can be prepared from shellac by either esterifying the carboxyl groups with an alkyl alcohol, or by condensing the hydroxyl groups with acids. The former reactions produce semi-liquid resins which can be used as resin plasticizers in lacquer while the latter reactions have been employed in preparing lacquer resins, and oil varnishes. Although these products have as yet only been studied superficially in combination with cellulose esters, they appear to offer many possibilities for new lacquer formulation and are well worthy of further contemplated study.

Pure alkyl esters of shellac, such as ethyl esters, are soluble in most of the solvents and diluents used in lacquer with the exception of the gasolene types. They give solutions of relatively low viscosities which can be used where products of high solid contents are desired for spraying. Their behaviour as a plasticizer for cellulose nitrate is not observed until they have been added in amounts equal in weight to that of the "cotton." Films from solutions containing four parts of shellac esters and one part of cellulose nitrate are hard, tough, flexible and adhere well to both wood and metal. They have therefore many of the characteristics of completely formulated lacquer films. The esters are completely compatible with a number of the synthetic resins of the different types, which fact suggests many possible combinations for using them in lacquer.

The materials obtained by heating lac with fatty acids (18) are also soluble in most of the organic solvents and likewise insoluble in petroleum ether and mineral spirits. The greater the degree of esterification the more soluble they are in the petroleum type of solvents. The proportion of lac in the mixture also affects the solubility

in these solvents. The esters produced from equal parts of lac and fatty acids for example can be thinned with white spirit while those from products with a ratio of 7: 3 of lac to fatty acids, require the addition of toluene. They can be dissolved in acqueous ammonia or alkalies and possess strong emulsifying properties.

Compounds of this type can be esterified with glycerine to give products of any desired acid value. Those made with drying-oil fatty acids have drying characteristics. They are compatible with cellulose nitrate in all proportions in the usual solvents. Like the alkyl esters, they impart adhesion and flexibility when used in large proportions in excess of the cellulose ester.

Lac-Drying Oil Varnishes.—Lac-oil varnishes may be successfully prepared by three processes, which can be summarized as follows:

(1) Heating together lac, fatty acids and glycerol in the presence of a catalyst, at 120-140° C. for a number of hours, till the acid value of the varnish falls to about 30.

(2) Partially esterifying the fatty acids with glycerol with the aid of a catalyst at 140° C. and then dissolving lac in the product. Alternatively, monoglycerides may be employed directly. Towards the end of the reaction a small amount of acids is added to convert the non-drying monoglycerides into the drying oil. This modification is a considerable improvement on the first process as the time required for making a varnish is considerably reduced.

(3) In this process, the catalyst is omitted, while the temperature is raised to 180° C.

Generally speaking, these varnishes possess excellent gloss and compare favourably with those made from rosin and ester gum as regards their drying properties. Products on storing for months in ordinary containers showed no marked tendency toward skinning. The films when baked have excellent resistance to both water and hydrocarbons, and for this reason may be particularly suitable for insulating varnishes and finishes where resistance to mineral oils are desired. They show good adhesion to vulcanized rubber surfaces. For pigmentation zinc oxide should not be used since it has a tendency to cause the resulting paint to liver. A green paint made with lithopone and Brunswick green pigments showed no signs of failure

after twelve months under natural weathering in Great Britain. Varnishes containing small quantities of tung oil showed signs of checking and cracking on exterior exposure, but no signs of chalking after eighteen months.

Shellac Acids.—Last but not the least, the study of the chemistry of shellac has suggested the use of this material as a source for polyhydroxy-acids. These acids possess many possibilities for the chemical synthesis of both synthetic resins (20) and possibly pharmaceuticals. The acids which can be isolated from shellac, as for example, aleuritic acid, would be very expensive to manufacture by present synthetic methods. We are studying at the present time a semi-plant process for obtaining these acids.

REFERENCES CITED

(1) Gardner, W. H., Off. Digest, Fed. Paint and Varn. Prod. Clubs, *No. 150,* 393-396 (1935).

(2) Nagel, W., And Mertens, W., Ber. 70, 2173 (1937).

(3) Bhattacharya, R. and Gidvani, B. S., Bull. 2, London Shellac Research Bureau.

(4) Schaeffer, B. B., Ph.D. Thesis, Polytechnic Institute of Brooklyn, 1936; cf. (ref. 5 a).

(5) Weinberger, H., Ph.D. Thesis, Polytechnic Institute of Brooklyn, 1937; cf. (a) Schaeffer, B. B., Weinberger, H., and Gardner, W. H., Ind. Eng. Chem. *30,* 451 (1938); Weinberger, H., and Gardner, W. H., ibid., *30,* 454 (1938).

(6) Harries, C., and Nagel, W., Ber. *55B,* 3822 (1922).

(7) Kirk, P., unpublished reports of the Shellac Research Bureau.

(8) Verman, L. C., and Bhattacharya, R., Technical Paper No. *8,* London Shellac Research Bureau.

(9) Gardner, W. H. and Kappenberg, W., Ind. Eng. Chem. *28,* 437-439 (1936).

(10) Payne, H. F., Off. Digest, Fed. Paint and Varn. Prod. Clubs, No. *159,* *297-304* (1936); cf. (a) Payne, H. F. and Gardner, W. H., Ind. Eng. Chem., *29,* 893-898 (1937).

(11) Gardner, W. H. and Gross, B., Brit. Plastics, *6,* 514 (1935).

(12) Gross, B., Metal Cleaning Finishing, *8,* 415-418, 489-491 (1936).

(13) Gibson, A. J., Empire Forestry J., *17*, 37 (1938).

(14) Ackerlind, E., Weber, E., and Gardner, W. H., paper presented before Subcommittee I of Committee D9 A. S. T. M., New York (1936).

(15) Ackerlind, E., and Weber, E., paper presented before the Electrochemical Society, Rochester, 1939.

(16) Zedek, M., B. E. E. Thesis, Polytechnic Institute of Brooklyn, 1935.

(17) Verman, L. C., and Bhattacharya, R., Tech. Papers *1* and *5*, London Shellac Research Bureau; Bhattacharya, R., and Gidvani, B. S., ibid., Tech. Paper *13*.

(18) Bhattacharya, R., Tech. Paper No. *12*, London Shellac Research Bureau (1937); Bhattacharya, R., and Gidvani, B. S., ibid., Tech. Paper *14*.

(19) Bhattacharya, R., and Gidvani, B. S., Paint Tech., *3*, 189-190 (1938).

(20) Unpublished reports of the Indian Lac Research Institute.

TABLE I

Fraction KIIB

	Found	Calcd. for $C_{32}H_{54}O_9$
Molecular Weight	565	582
Acid Number	103.6	96.2
Saponification Number ...	286.3	288.6
Ester Number	182.7	192.4
Hydroxyl Number	521	481.0
Elementary Analysis C	64.76	65.98
H	9.22	9.28

Fraction KIB

	Found	Calcd. for $C_{48}H_{84}O_{14}$
Molecular Weight—Sap. No.	878	884
Rast ...	785	...
Acid Number	90.6	63.3
Saponification Number ...	255.3	253.2
Ester Number	164.7	189.9
Elementary Analysis C	65.74	65.15
H	9.29	9.50

Official Digest No. 180, 473—478, November, 1938: Drugs, Oils and Paints No. 12, 438—441, December, 1938. Polytechnic Institute of Brooklyn, N. Y.

INDIAN FORESTER

MARCH, 1941

THE CONTROL OF LANTANA BY A SODIUM CHLORATE SPRAY.

By A. L. Griffith, Central Silviculturist, F.R.I.

Summary.—Work in the North Salem Division of Madras on the possibilities of controlling the pest **Lantana** with chemical sprays has been going on since 1934 but has now come to a temporary halt as owing to the war it is not now possible to obtain supplies of the necessary chemicals.

The experience gained so far shows that successful control by spraying with sodium chlorate is possible at a cost of roughly Rs. 10 per acre and that such a spray has no toxic effect on subsequent regeneration in the area.

Owing to the comparatively low cost involved (we often spend as much as Rs. 10 per acre in many kinds of plantation work), this method becomes possible in accessible areas with good communications where land is valuable.

Introduction.—Some interesting work has been going on in Madras since 1934 on the control of the pest *Lantana*. Most of this work has been done under the supervision of the Provincial Silviculturist by Rao Sahib S. Rangaswami, Research Ranger, Denkanikota in North Salem Division.

Details of the work have been published year by year in the Madras Silvicultural Research Report, but many requests have been received for further information on the subject. Owing to the war it is now almost impossible to get supplies of sodium chlorate and hence the work has had to be stopped temporarily.

In consequence, it is thought that the present is a suitable time to describe and sum up the work done so far, so that when it is resumed after the war the best use may be made of the experience already gained.

Importance of Controlling the Pest.—The importance of investigating all possible methods of controlling the pest is well illustrated by the rate at which it is spreading. In making the Working Plan for North Salem Division in 1917 Mr. Wilson records that the extent of *Lantana* in reserved forest alone was roughly 4,800 acres. In the

1935 Working Plan Mr. Ranganathan found that the area of *Lantana* had increased to 56,000 acres, while a very recent estimate puts the area as just over 100,000 acres. It is to be remembered that this is the area of *Lantana* in reserved forest alone in one division.

The density of the *Lantana* is often as much as 5,000 to 10,000 stems per acre. (See Plate 4, Fig. I.)

In addition, North Salem Division is a *sandal* division and it has been proved that *Lantana* is a bad host for *sandal* as it predisposes it to spike disease. It is largely the *sandal* forests that this pest is invading in North Salem Division.

Preparation of the Solution.—$\frac{1}{2}$-lb. of commercial sodium chlorate is dissolved in 1 gallon of water and 2 ozs. of casein are added to the solution. The resulting solution is diluted with 1 gallon of water.

When casein is used as a "spreader," it has to be dissolved in an alkaline solution; a little *chunam* or a pinch of bicarbonate of soda is sufficient for this purpose.

Source of the Chemicals.—Sodium chlorate and casein can be obtained (in normal times) from any firm dealing in commercial chemicals. If any difficulty should be experienced in getting supplies, the Central Silviculturist may be consulted.

Types of Spreaders.—Various spreaders for this spray have been tried and the best so far found is casein. It is, however, expensive and soft soap and linseed oil have both been found nearly but not quite so effective and, of course, much cheaper. Further experimental work on spreaders for this spray is needed.

Type of Sprayer.—The type of sprayer found most convenient is one of the knapsack type with a container of 2 to 5 gallons capacity. The spraying arm should be about 6 to 8 feet long, and several different aperture nozzles for varying types of growth and weather conditions are very advantageous. A good sprayer with all accessories can be obtained for about Rs. 18 to 25.

Method of Spraying.—In order to get into the *Lantana* for spraying, narrow lines about one foot wide and about 20 to 25 feet apart are made. The lines are cut just sufficiently to allow a man with his sprayer on his back to pass through. These lines should, if possible, be at right angles to the prevailing wind.

Time of Spraying.—To have most effect, spraying should be commenced early in the hot weather. It should not be done soon after rain or when there is likelihood of rain.

Quantity of Solution Necessary.—The research done so far shows that with a concentration of $\frac{1}{4}$ lb. of sodium chlorate per gallon, the complete control of the pest in an area of 10,000 stems per acre density can be accomplished by the use of about 34 gallons of solution per acre applied in three sprays of 24, 8 and 2 gallons per acre respectively.

Effect of the Sprays.—*Lantana* regenerates itself chiefly by seed and by coppice. It very rarely reproduces by root-suckers. It is this fact that makes its control by chemical spraying come within the realms of possibility. By using a sodium chlorate spray of the strength and quantity noted above the *Lantana* on the ground can be got rid of and re-invasion of the area held off until a new forest crop is established which can look after itself. In the ordinary way, after clearing the ground by spraying, if the area is just left as it is, it takes two to three years before birds, etc., have brought back the pest.

In the early years of this work in Madras some misunderstanding arose over the rather unfortunate use which was made of the word "eradication" in connection with it. It is, therefore, brought to notice that the spray *controls* the pest but does not permanently *eradicate* it. It controls the pest until a new crop is established on the area that is able to keep out the pest for itself.

With the strength of solution mentioned above, usually only the *Lantana* is affected. A slight withering of the tender shoots of other species occurs after spraying but they usually subsequently recover. An example of this is that in order to remove *Lantana* weed growth it is quite safe to use a light spray on *Cassia siamea* plants of six inches to one foot high.

The first spray is usually done about February and consists of 24 gallons of solution sprayed evenly per acre. Withering of the *Lantana* leaves is seen on the same day and, within five to seven days, all leaves completely wither and the top twigs down to a length of about three to four feet completely dry up. Regrowth begins to come up after 15 to 20 days from the date of spraying. The withering of

foliage and top shoots lets in light and encourages the mass of seed which was dormant on the ground to germinate. When this regrowth and fresh germination is complete, a second spray of eight gallons per acre is done. This is usually somewhere about April (i.e., about three months after the first spray). This second spray kills most of the regrowth and the new germination but in some cases a third spray is necessary as some of the older stumps give rise to weak basal shoots. This third spray usually consists of about two gallons per acre and is done about September or October, i.e., roughly nine months after the first spray (*See* Plate 4, Fig. II).

After the second spray is complete in its effect the *Lantana* is compressed and burned and artificial regeneration operations started (*See* Plate 5, Fig. I). In the climate of North Salem Division which has an annual rainfall of approximately 30 inches, most of which comes with the North-East monsoon in October and November, the regeneration of the sprayed area is done about August-September. The third spray is thus usually a weeding of the new regeneration. It can be done when the artificially regenerated crop is six inches to one foot high, to kill weeds and any *Lantana* that still survives. It will do no permanent harm to the young crop. It should be noted that after these three sprays occasional *Lantana* stumps (say of the order of perhaps 30 to 50 per acre) do send up weak shoots from the base that are easily dealt with. The great majority of the old tough stools, however, do not send up any further shoots at all but slowly die. The time of this third spray depends very largely on the forwardness or otherwise of the forest crop regeneration and also, of course, on the weather.

Effect of Season of Spraying.—Experiments on the effect of the season of the first spray showed that it has its greatest effect if done at the beginning of the hot, dry season about February. Regrowth of *Lantana* was much quicker and more profuse after August spraying than after January-February spraying.

Effect of Different Concentrations of Sprays.—Experiments showed that a spray of ½ lb. of sodium chlorate per two gallons of solution was much more effective than a spray of ¾ lb. of sodium chlorate per two gallons of solution provided that the quantity of sodium chlorate sprayed per acre remained the same. In other

Fig. I

A *Lantana* area in Joganur R.F., selected for spraying experiments. Density of *Lantana* 5,000 to 10,000 stems per acre.

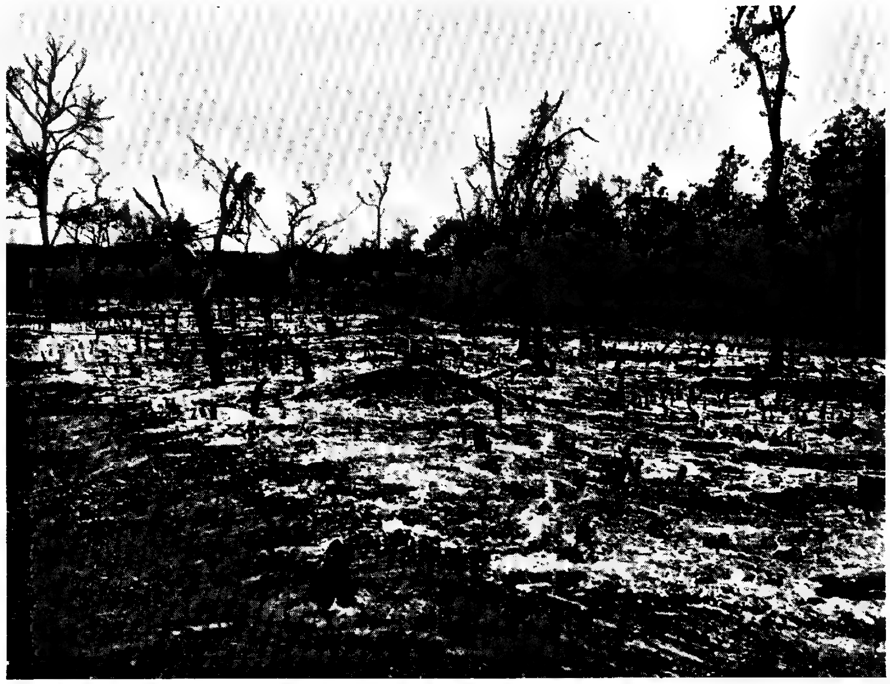
Photo: S. Rangaswami, 1936.

Fig. II

A *Lantana* area in Gulhatti R.F. immediately after the second spray.

Photo: S. Rangaswami, 1936.

Fig. I



The same area as in Plate 4, Fig. II, but after the dead *Lantana* had been compacted and burned after being killed by 2 sprays.

Photo: S. Rangaswami, 1938.

Fig. II

The same area as in Plate 4, Fig. II and Plate 5, Fig. I, after regeneration by sowing with *Cassia siamea* (5 months old).

Photo: S. Rangaswami, 1938.

words, the weaker spray, sprayed more thoroughly, had the bigger effect. Experience has shown that the increase in cost per acre of using a larger quantity of a weaker solution was trifling.

Effect of a Reduced First Spray followed by a Light Second Spray.—Experiments have shown that a reduction of the quantity of solution for the first spray may be possible but it is definitely not as effective as a 24-gallon-per-acre spray. These experiments also showed that a reduction of the second spray below eight gallons per acre is not possible without serious loss of efficiency. Further work in this subject is necessary.

Regeneration of the Sprayed Area.—The area should be regenerated with a valuable crop as soon as possible after the effect of the second spray is complete. In North Salem Division such crops as bamboos (*Dendrocalamus strictus* and *Bambusa arundinacea*) and *Cassia siamea* have been successfully raised on sprayed areas. *This shows that the spray used as described has no toxic effect on the soil so far as subsequent regeneration is concerned* (*See* Plate 5, Fig. II).

Costs.—As a result of the work done in North Salem Division since 1934 a typical estimate for work on a large scale is:

Density of Lantana	...	10,000 stems per acre.	
Rate of cooly wages	...	Rs. 0-4-0 per day.	
Cost of sodium chlorate bought in bulk	...	Rs. 0-8-0 per lb.	
Cost of solution—			
½ lb. of sodium chlorate to 2 gallons	...	Rs. 0-4-0	0-4-2
Spreader	...	Rs. 0-0-2	
or	...	Rs. 0-2-1 per gallon.	

COSTS PER ACRE

	Rs. as. p.
Line cutting in order to get into the areas to spray. Lines to be 25 feet apart and 1 foot to 2 feet wide. Total per acre approximately 32 chains (external demarcation of the area is not necessary in large areas of district work as the outside spray lines serve the purpose)	1 0 0

	Rs.	as.	p.
First spray—24 gallons—			
Spray	3	2	0
Labour	1	4	0
Second spray—8 gallons—			
Spray	1	0	8
Labour	0	8	0
Compressing and burning the dead *Lantana* ...	2	8	0
(Here comes the start of regeneration works such as sowing, planting, etc., etc.)			
Third spray—2 gallons—			
Spray	0	4	2
Labour	0	4	0
(This third spray also serves the purpose of a weeding for the new regeneration).			
Total ...	9	14	10

or roughly Rs. 10 per acre.

Other Chemical Methods Tried.—(*a*) Girdling the *Lantana* and poisoning with arsenic solutions cost approximately Rs. 15 per acre and although it dealt with the *Lantana* successfully both in above-ground and underground portions, it did not deal with seed dormant on the ground. Hence a spraying of the new germination was also necessary and must be added to the cost given. The girdling was done at a height of one to three inches above ground level. No *Lantana* was cut within the plot but a small amount of clearing had to be done to facilitate the work.

(*b*) Cutting and burning the *Lantana* and controlling the re-growth by spraying with sodium chlorate was quite successful but cost approximately Rs. 13-8-0 per acre. The initial cutting and burning of the Lantana was expensive and cost Rs. 5 per acre and this extra expense more than outweighed the saving in spraying of approximately Rs. 1-8-0 per acre. Cutting and burning the *Lantana* as a preliminary to spraying is thus not advisable.

(*c*) Various other chemicals were used for spraying as follows:

Name of chemical	Strength of solution
1 Ammonium thiocyanate ..	100 grams per gallon of water.
2 Potassium chlorate ..	100 grams per gallon of water.
3 Sulphuric acid ..	1 oz. to one gallon of water.
4 Ethylene chlorohydrin ..	6 oz. to one gallon of water.
5 Copper sulphate ..	4 oz. to one gallon of water.
6 Magnesium chloride ..	4 oz. to one gallon of water.
7 "Atlas" tree-killer solution ..	1 to 20 parts of water by volume.
8 "Atlas" substitute solution ..	1 to 20 parts of water by volume.
9 Aluminium sulphate ..	50 grams to 1 gallon of water.
10 Arsenic acid ..	4 oz. to 1 gallon of water.
11 Potassium thiocyanate ..	4 oz. to 1 gallon of water.

Items 3, 4, 5, 6 and 9 had no effect at all. In the cases of Items 1 and 11 the *Lantana* shed its leaves but shot up again quickly. With Items 2 and 10, the *Lantana* shed its leaves and the top twigs up to a length of one to two feet died but it shot up again quickly from below. With Items 7 and 8, the effect was very thorough in the beginning as all leaves and shoots up to 2½ to 3 feet long died, but it had no effect on the seed dormant on the ground and the stools shot up again quickly showing that the roots had not been affected.

Silvicultural and Entomological Methods of Controlling the Pest.—A considerable amount of work has been done in the control of *Lantana* by silvicultural methods such as underplanting it with fast-growing species such as bamboos. This work has met with considerable success at a comparatively small cost but its description is outside the scope of this note.

The prospects of the entomological control of the pest have been dealt with recently in Indian Forest Records (New Series) Entomology, "Possibilities of Control of *Lantana* by Indigenous Insect Pests," by Beeson and Chatterjee, 1940.

Need for Further Work.—After the war, further work is very necessary on spreaders, on different concentrations of the sodium chlorate solution and on the effects of different total quantities of solution per acre.

It is anticipated that refinements in method will result in a greater effect for a smaller outlay.

Indications of the Work.—The work done so far indicates that in climates like that of the North Salem Division of Madras, *Lantana* even of a density of 10,000 stems per acre can be controlled by a sodium chlorate spray and re-invasion of the area by the pest held off until the new forest crop is established and can look after itself.

Sufficient experience has now been gained to show that this spraying with sodium chlorate is the cheapest and the most effective way of controlling the pest that has so far been tried in this work in Madras.

Its cost is roughly Rs. 10 per acre and this means that where communications are good, and land is valuable, the method comes within the scope of practical possibility.

"FROGGIE WOULD A-WOOING GO—."

Froggie would a-wooing go—
"Heigh-ho!" says Hitler,
Whether his honour would let him or no—
With a roly-poly of impropaganda,
"Heigh-ho!" say Musso and Hitler.

"Mon cher Monsieur Laval, *pray come to dine—*
Heigh-ho!" says Hitler,
"And the French fleets' destroyers shall also be mine—
With a roly-poly of impropaganda
"Heigh-ho!" say Musso and Hitler.

"But what shall we do about General de Gaule?"
"Heigh-ho!" says Petain,
"For there *is a Frenchman who still has a soul*
In spite of our poly of impropaganda—!"
"Heigh-ho!" say Musso and Hitler.

"If we sell out to Hitler, there may be revolt—
"Heigh-ho!" says Petain,
"And Laval and I, we may both have to bolt,
With our roly-poly of impropaganda—!"
"Heigh-ho!" say Musso and Hitler.

"Oh, the end of this ditty is not yet in sight—"
"Heigh-ho!" sighs Hitler,
"Though we've won the first round of the
MIGHT versus RIGHT—
By our roly-poly of impropaganda,
"Heigh-ho!" say Musso and Hitler.

"What a rotten bad showing we make against Greeks—
"Heigh-ho!" sighs Musso;
"My troops are retreating with terrified squeaks,
And people just laugh at my *impropaganda—"*
"But we are not amused," *remarks Hitler!*

"My navy is sunk, leaving scarcely a boat—
Heigh-ho!" sighs Musso;
"And oceans of Bovril* *won't get it afloat*
On account of the British Fleet Air Arm's agenda,—
I know—!" Say Musso (and Hitler).

"I am battered and bruised, I am weary and sore,
Heighbloodyho!" says Musso,
"And I wish I had never come into the war,
By lending my ear to your impropaganda—"
"YOU'RE NO USE WHEN YOU'RE IN IT!"
—Says Hitler.

H. J. C. M.

**Does Musso know this remedy for "that sinking feeling"?*

SAL REGENERATION DE NOVO IN B_3 SAL

BY W. D. M. WARREN

Summary.—The premonsoon rainfall of the United Provinces forest is poor compared with Singhbhum, Bihar, and would appear to have diminished during the past century due probably to heavy fellings outside the Reserves. It may perhaps account in part for *sal* regeneration difficulties of the Bhabar Tract. Contour trenching in the drier forest types, by improving the forest growth, would bring about a climatic improvement.

I was very interested in Mr. Raynor's reply to my note on the above subject (September issue). Mr. Raynor makes an important point when he quotes Champion as stating that there is much in common between the moist Western Himalayan *Sal* (B_1 Type), and the moist Peninsular *sal* (B_2 Type) of Singhbhum, and that in both, annual burning has long since been given up as detrimental. In both types *sal* regeneration presents little difficulty. In fact it would appear that the United Provinces uses annual burning only where *sal* regeneration does present a difficult problem, for example, in the Bhabar Tract.

Mr. Raynor quoted Champion. In my wrestling with this problem—and indeed it has been a wrestle!!—I have been helped tremendously by Champion's powerful descriptions of the *sal* forest types of the United Provinces. Mr. Lochner, of Messrs. Bengal Timber Trading Company, a U.P. man, has also helped, and so has Mr. Ahmad, my newly fledged assistant.

Mr. Raynor states that there is sufficient regeneration in the Bhabar Tract (B_3 *Sal*) even to survive the annual burnings and that these burnings are carried out chiefly for the sake of cheapness. But the weakness appears to lie in the fact that the regeneration has not reached the whippy stage, and that from seven to fifteen years must be spent in annual burnings in order to get the *sal* regeneration to that state (Smythies and Research Report for 1938-39). Now that is a long time to wait, and requires a great deal of patience. Moreover, the burnings must be carefully carried out every year at the proper time, neither too soon or the weeds won't burn, nor too late or the fire may be too fierce. How much better then, if it were possible to find the *sal* regeneration already there in the whippy stage on the ground beneath the weeds!! That is what happens in Singhbhum. However thick the weeds may be, the *sal* regeneration

in the whippy stage is found beneath. Only the other week I examined an area in Moist Peninsular *sal*, where only the width of the road separated it from evergreen forest, rainfall 70—80 inches. Big openings had been made in the overwood by the P. B. VI fellings, some years previously, and a mass of weeds had come up, conspicuous amongst them being Millettia creeper, found also in the United Provinces. [*Clerodendron* is also common with us, as also *Holarrhena*, though *Mallotus* is more scarce.] Looking at the area, my Ranger ventured the opinion that it would now be necessary to cut and burn it and to plant up with teak. Yet beneath that mass of weeds was to be found *sal* in the whippy stage only waiting for the sickle to cut back the weeds two or three times to establish itself as the future crop. That regeneration was probably in the whippy stage before the overwood fellings were made, hence its survival and apparent healthiness under the mass of weeds. The more this problem is studied, therefore, the more convincing does it become that our good fortune is chiefly due to possessing a more favourable pre-monsoon climate which, in one year, creates favourable soil moisture conditions for germinating the fallen *sal* seeds and, in the next year, enables the seedlings to survive.

In the struggle for existence in B_3 *Sal*, the rainfall figures for May and June have been shown to be adverse—at least they are not nearly as good as those for Singhbhum, the B_2 Type of which may be looked upon as in the climatic climax for *sal*. There is possibly another benefit which earlier and more abundant rains might bring. It might enable the *sal* regeneration to commence its growth earlier in the hot weather, and so to gain an advantage over the weeds. Observation of the contour-trenched irrigated hill *sal* regeneration in the hot weather of 1937 showed that it had grown six inches to one foot whereas the valley QII-III regeneration of the C.W.C. area of a normally damper block, some fifteen miles away, was still dormant. Whether ample water supply at that time of the year would equally stimulate *Mallotus, Clerodendron, Millettia, Holarrhena* and *Pogostemon,* common weeds and undergrowth of the Bhabar *Sal*, I do not know. In any case, Mr. Raynor admits that a slightly higher incidence of rainfall at the opening of the monsoon would probably be beneficial, but he considers that there is no case for contour trench-

ing in Bhabar B_3 *Sal* as it is distinctly different to Singhbhum in climate, terrain and growth.

Mr. Raynor has, however, misunderstood me. I did not suggest that the Bhabar Tract, which is flat or gently sloping itself, should be contour-trenched. On the contrary, I suggested that this treatment should be applied to the forests around the Bhabar Tract, that is, to the drier tracts. Indeed there is no point in contour-trenching forest which, from the level nature of the ground and the luxuriance of the overwood and underwood, forms such an effective mechanical resistance to the runoff as probably to ensure practically complete absorption of all monsoon showers. We get far too little money to waste any of it on such useless expenditure.

According to Champion, the drier tracts are classified as belonging to the A_2 Dry Gangetic Alluvial *Sal* or, in the Siwaliks, to the A_1 Dry Siwalik *Sal*. From his descriptions both types would appear to be ideally situated for carrying out contour-trenching experiments. In the A_1 Type we read that "Sal regeneration is usually scarce except for occasional patches and is frequently absent. Soil moisture is the limiting factor. The quality of the forest is low generally QIII/IV." and "the dry *sal* forests are of relatively little economic importance owing to their low quality." Both Champion and Smythies speak of "southern exposed slopes." That description would apply equally well to the Bihar A_3 Dry Peninsular *Sal* except that in the Kolhan Division where contour-trenching has been done on a comparatively large scale, the quality is even poorer—QIV/V—some trees not even reaching 50 feet in height. And yet, in Kolhan, results have been astonishing both with regard to regeneration and growth. (In the A_1 Type of the United Provinces, however, the forests are growing on sandstone and conglomerate which may not be as retentive of moisture as the Singhbhum shales and so might not give quite as good results.)

Champion's description of the A_2 Dry Gangetic Alluvial *Sal* of the United Provinces is very illuminating. This type enjoys the same sort of climate as the moist High Level B_3 Type "except perhaps for greater exposure to the desiccating *loo* wind with correspondingly higher maximum temperatures." "Most of the forests were apparently fairly average moist *sal* forty to fifty years ago, but

recurring waves of mortality associated with periods of drought have swept over them, killing out groups and patches and reducing other areas from well-stocked forest to a dry, deciduous type. Natural regeneration in the whippy stage is entirely absent," "The evidence all indicates that moist high level sal is locally retrogressing to a more xerophytic type." This is believed to be due to "the very extensive clearing of the country which has taken place during the century (Bailey) and this might well influence both rainfall and temperature."

In the face of this description, coupled with the low rainfall figures for May and June, it can scarcely be doubted that the pre-monsoon climate of the United Provinces is now adverse compared with what it was before the extensive clearing took place. For it is an undisputed fact that when a climate retrogresses, it is the instability rains which suffer first, and these are so important for the maintenance of healthy *sal* forests.

This climatic retrogression is not a phenomenon peculiar to the United Provinces; we have it on the Ranchi Plateau in Bihar, threatening the tea plantations with slow extinction, while the dry fuel forests of Madras appear to have suffered from the same cause, showing the evil to be widespread.

In these dry forests, soil moisture is seen to be the limiting factor for growth while the hotter, dryer climate now prevalent in the United Provinces has caused a retrogression of type in certain parts of the Bhabar Tract. It would appear that an improvement of the conditions governing the regeneration of these forests can only be brought about by an improvement in the pre-monsoon climate. The problem would, therefore, appear to be, How to bring about that improvement in climate? The answer is to be found in the rather startling statement made to me by Dr. Normand, Inspector-General of Meteorological Stations at Poona, on the boat going Home last year.

He said, "If you raise the soil moisture you automatically modify your climate." By this he meant that if you increase the soil moisture, you increase the forest growth and that automatically will increase the transpiration from the more abundant leaves. The

increased transpiration will have an increased cooling and humidifying effect on the atmosphere. The increased leafage area of the trees will also reflect back the radiant heat of the sun to a greater extent, keeping the earth cooler and moister beneath its shade.

Apart from any increase of rainfall, the cooler temperatures and higher relative humidities, by slowing down the rate of evaporation losses of soil moisture in the hot weather, will cause a decrease in mortality both of the mature trees and of the seedling regeneration.

I understand that seedling mortality is very heavy in the United Provinces, causing the good seedling crop of a good seed year to be entirely wiped out if the next hot weather happens to be severe.

That contour-trenching does increase the soil moisture, and so automatically the climate, can be proved by subjecting soil samples of comparable plots taken from different depths within and without the contour-trenched areas, to laboratory tests for moisture content. It is even possible to assess the value of the increased soil moisture in terms of growth by comparing with Hellreigel's Barley Growth Curve (1883) for different percentages of soil moisture on the assumption that *sal* growth would respond somewhat similarly (Russell).

This cooling and humidifying of the *loo* wind was exemplified last summer on May 7th when the temperatures down below at Chaibassa (height 800 feet) were 108°-109°F. My assistant, Mr. Ahmad, and I were at Bamiaburu (height 1,250 feet) on my annual pilgrimage there, when at midday he opened the door on to the southern verandah exclaiming, with some surprise, "This wind is neither hot nor dry!!" The temperature in the shade at the time was just under 100°F., yet that hill had formerly been both hot and dry in the hot weather. The *loo* had traversed six miles of forest, three of which had been contour-trenched. The lowered temperatures have decreased the capacity of the air for holding moisture while the raised humidities have brought the moisture vapour nearer the precipitation point. When disturbed meteorological conditions arise, therefore, bringing in extra moisture from the outside, the local climatic conditions are now more favourable for precipitation than they were with the former higher and dryer temperatures, and the effect is sometimes to produce rain where none ordinarily would have fallen.

However, the reader is more likely to be impressed by figures showing this climatic improvement than by mere theory. Here, then, are a few:

Taking 1937 as a good, cool, rainy year as normal (it was a peak year of rainfall in Chaibassa), the average maximum temperatures for the two years 1938-39 at Bamiaburu averaged 2.1°F. less in the month of May, and minimum temperatures were 2.6°F. less, humidities were down by ten points although still high, rainfalls were normal but the number of rainy days was up by 3.5. This is in spite of the fact that 1939 was exceptionally hot and dry in May, with only the little group of stations, Bamiaburu, Sonua and Roro, all within ten miles of each other, showing any rainfall at all in the whole District, which included several other forest rainfall recording stations!! What a pity that there is no proper normal for Bamiaburu to show the precise amount of change!!

In Chaibassa, fourteen miles from the nearest point of the experiment, where there is a *pacca* normal, the four-year complete climatic cycle, 1936—39, shows a reduction of 1.2°F. in the average maximum temperatures for May, a rise of 1.15°F. in the minimum (1939 was exceptionally severe), a rise in the relative humidity of six points and a rise of .25 inches in the rainfall, while the number of rainy days is up by 3.8. These figures are the more impressive because up till now climatologists are very sceptical about the influence of forests, on places outside [Chaibassa is 8—10 miles from the edge of the forest].

These figures are likely to improve, as the improving and thickening forest growth grows up to a complete canopy.

In Chota Nagpur, clouds in the pre-monsoon period formerly used to wander about, perhaps for some days, without causing precipitation, but the cooling effect of the contour-trenched area seems to cause those clouds to drop their moisture. In this way the monsoon is advanced, or rather the *Chota Barsát,* which precedes the real monsoon, is intensified and advanced. This explanation, I trust, will clear up Mr. Raynor's doubts. Let me emphasise, however, that one cannot create disturbed meterological conditions—that is beyond

our control—all we can do is to take the maximum advantage of them when they do come.

The next point Mr. Raynor raises is that the terrain will not permit of contour-trenching. The hill slopes, unless precipitous of the A_1 Dry Siwalik Type, would, I presume, present no difficulty and contour-trenching could be carried even into the dry mixed forest type which would, in consequence, probably progress to *sal* forest, if any scattered seedbearers of *sal* are in the vicinity. It is the level or gently sloping A_2 retrogressed from B_3 Type, I imagine, which if the B_3 Type is ruled out for contour-trenching as being unnecessary, Mr. Raynor might perhaps consider to be unsuited for contour-trenching. Even on such land, however, there must be a considerable runoff with such poor vegetation to stop it.

In this connection I would point out that most of the American runoff experiments were conducted on gently sloping land fit for agricultural crops and they proved conclusively the value of thick vegetative cover for stopping that runoff. Any trenches dug in the A_2 Forest Type, having a fairly good catchment area above, say, one hundred yards or more, are almost certain to get filled with water in heavy downpours, thus adding to the soil moisture. Nahan sandstone outcrop soils especially will require every drop of water that can be held up as they are less retentive of moisture than clays and loams.

To sum up, if an improvement in the climate of the Bhabar Tract is considered desirable, this can best be affected by improving the growth of the dry tracts A_1 and A_2 *Sal* in the neighbourhood, as it is in these tracts that the greatest improvement in forest growth can be brought about. Rigid fire protection over a long series of years produces an improvement but it is a slow process, the improvement probably not amounting to more than half a quality in a rotation of 120 years (U.P. estimate). The drier and the more infertile the tract, the more stubborn will it prove to be. Contour-trenching, on the other hand, by stopping the runoff, brings about a much quicker vegetative response, the improvement of which may even amount to as much as $1\frac{1}{2}$—2 qualities!! The climatic improvement will also be hastened and will be more intense.

A word of warning must be given. Contour trenching is not of much use where the forests are heavily grazed, as excessive silting takes place, which would necessitate redigging the trenches nearly every year—an expensive nuisance.

BIBLIOGRAPHY

CHAMPION, H. G.—Regeneration and Management of *sal*.

SMYTHIES, F. A. and HOWARD, S. H.—A *Sal* Yield Table for the United Provinces.

RUSSELL, SIR JOHN—Soil Conditions and Plant Growth.

P. S.—Mr. Ranganathan has just visited me with his Ranger students. He points out that much of the *sal* regeneration mortality of the United Provinces occurs during the month of October after the rains have finished. In Singhbhum we get about four inches of rain in that month. The rainfall statistics in the area of Bamiaburu influence have not so far been examined to see whether there are signs of rainfall improvement then or not. Should an improvement be detected, it would be arguable that the United Provinces might expect one also from any experiment on a large scale they might carry out. In any case, the same argument of lowered temperatures and raised humidities of the pre-monsoon climate would apply to this month also for reducing mortality in the *sal* seedlings. A cooler, more humid October, even though no rain fell, would certainly be more favourably for seedling growth asd survival. Statistics at Bamiaburu have already shown indications of a cooler, moisture October-December period, the maximum temperatures for 1937-38 being down by 1.9°F. and the minimum temperature by 5.35 F. (!!) as compared with 1936, although final proof belongs to the future.

Research into the effect of improved forest growth on climate is a most interesting study but I would wish that there were more research workers!!

EXTRACTS

THE CAUSES OF FAILURES IN YOUNG PLANTATIONS

W. H. ROWE

Everyone who undertakes a planting operation, whether it be a forest or a single tree, is concerned with the question of failures and deaths. An experienced forester appreciates the nature of the problem and knows how to minimize the losses, but in the minds of many less experienced people there is much confusion of thought. Every nurseryman is familiar with the sort of complaint which reads:—"I am sorry to say that over half the trees supplied are dead although they were planted with every care by a skilled man and without delay." The complainant usually adds that there was plenty of rain or that the plants were watered regularly and infers from this that the trees must have been faulty. It is true that bad planting, drought and poor quality trees may cause failures, but they are not the only causes and the whole question of deaths requires more than a superficial consideration.

A cause of death may be primary (direct), i.e., one which directly causes death, or secondary (predisposing), i.e., one which does not cause direct death but which creates conditions favourable to certain other primary causes. For example, severe drought may be a primary cause. The beech coccus (*Cryptococcus fagi*) is frequently a secondary cause for, while it may not kill the tree, it will create conditions favourable for attack by *Nectria ditissima* which will be a primary cause of death.

A tree is a complicated organism the life of which depends upon the functioning of its delicately balanced mechanism. The live tissues are composed of a very large number of living cells differentiated into various specialized tissues such as parenchema, sclerenchema, etc., but the whole is integrated into one living unit. The life of the tree is the summation of the life in the individual cells. Anything which deranges the delicate mechanism of the tree causes the cells to die and, if the disturbance is sufficiently severe, all the cells may die, either immediately or gradually, until the whole tree is dead.

The causes which may bring about this disturbance or cessation of the life process are (1) Accidental, (2) Pathological, (3) Physiological. Accidental causes are those which produce damage to the anatomical structure of the tree and may in some cases be primary and in others secondary causes of death. Fire, ice, snow, lightning, storms, frost, excessive heat and animals may all damage young trees to a greater or lesser extent. Falling trees and careless cleaning are other accidents that may occur. Under this heading we may also include insects which damage the structure of the tree, suck the sap or pave the way for disease. Some of these things are in the nature of being "Acts of God," but others can be prevented or their effects can be minimized.

Poisoning is closely akin to an accidental cause. This may occur through the soil or the atmosphere. It may be mechanical, as when the roots become clogged and cannot absorb food, or when the lenticels and stomata are choked so that respiration is prevented. At the same time poisons in the soil or in the air may produce a direct toxic effect resulting in destruction of tissues. Although poisoning is not frequent in plantations, unless the air be contaminated by obnoxious fumes or the soil be sour and stagnant, yet rubbish, etc., buried in gardens does sometimes produce these effects. It is also known that lime and some other chemicals seem to produce a toxic effect on some varieties of trees.

The pathological causes of death are legion and include all the parasitic fungi and parasitic plants which may destroy the tissues or feed upon the substance of the plant. Healthy trees, like healthy human beings, show considerable powers of resistance to disease, while lowered vitality due to unfavourable surroundings or other causes encourages attack.

The physiological group of causes is probably the most important because these causes of death are the most common, while at the same time they are frequently the least apparent to the eye, and the most difficult to diagnose. They do not produce immediate visible destruction of tissue, but they disturb the balance which must exist between the absorption of water (containing food in solution) by the roots and transpiration by the leaves. The resulting condition is like pernicious anæmia combined with starvation. Any factor which

results in (1) excessive transpiration or (2) severely reduced root activity will make for death.

The rate of transpiration will be greatly influenced by the temperature and humidity of the atmosphere and by wind. Whereas warmth is essential to growth, much heat will produce excessive transpiration and this will be further intensified by a very dry atmosphere. Wind increases transpiration particularly if it is a dry or cold wind, and in the spring of each year this accounts for many failures among newly planted trees, as far more moisture is drawn out of the tree than the partly established roots can supply. Evergreens are especially liable to suffer from this cause owing to their more extensive leaf surface. Some plants such as holly and laurel frequently shed their leaves just after planting and flush again later in the year. This is nature's way of protecting the tree against excessive transpiration. If the foliage of evergreens be sprayed with water this will often help to reduce the effects produced by wind and sun.

The degree of root activity is dependent upon a number of factors. When a tree is transplanted the physiological circuit is temporarily broken and the tree is faced with the problem of re-establishing itself in its new surroundings. This it must do sufficiently quickly to enable it to absorb enough moisture to counteract the amount lost by transpiration. It is a question of time. The known factors which influence this may be considered under three headings.

(1) *Soil.* The mechanical and chemical conditions of the soil, the moisture content, the temperature and the degree of aeration all influence growth and must all be taken into consideration. Satisfactory growth can only take place within certain limits, although these limits vary in different species. A deficiency or excess of almost any soil factor may result in failures. Drought, for example, may induce severe malnutrition, but too much water will create a lack of air and will reduce the temperature, while it may also produce acid poisoning. During the summer evaporation will be reduced if the soil surface is broken, while low growing surface vegetation will help to conserve moisture. For this reason it is possible to clean a plantation too well.

(2) *Planting.* The essential of good planting is that the operation shall be so conducted that the roots of the tree can establish the best possible contact with the soil in the shortest possible time, so that the tree shall be able to avail itself of the nutriment in the soil. Rootlets which are bunched together will only have partial contact, and they will only have a limited area from which to draw sustenance. If the soil is well broken up and friable, root contact is further assisted and root penetration is made easier. Loose planting also makes contact more difficult.

The best time for planting is a matter on which much misapprehension often exists. One is frequently asked whether it is too late to plant larch in the middle of November or a thorn hedge in February! It may be that some conifers, especially Corsican pine, *Thuya plicata,* holly and yew, are likely to do best if planted when there is some root activity, i.e., in autumn or spring, but it is possible to overestimate the real importance of this factor, and there is ample evidence to show that these varieties can be planted at other times with highly satisfactory results. It would seem from experience that climatic and soil conditions are of far greater moment than the calendar date, and these are factors which may vary from year to year and in different districts. It may be found in certain districts that in normal seasons suitable conditions exist in November and December, and if planting is done then the trees will get "settled in" before growth commences in the spring. On the other hand, a very dry period during these months would suggest postponement. A heavy tenacious soil may only be suitable for planting after a dry period, whether this occurs in October or March. Experience and knowledge of a particular district will have to decide the question. In all cases, however, the general conditions prevailing in the period immediately following planting will influence the proportion of failures.

(3) *The Tree.* We have so far considered the external environment of the tree, but success will also depend upon the tree itself, that is upon its quality, condition and age. If the tree is to stand up to the disturbance of transplanting it must have been well grown, it must be vigorous, and its various parts—roots, stem and foliage—must be well balanced. The plant must be healthy and must reach

the planting area without becoming unduly dried or heated in transit. While the tree is out of the ground it is impossible to avoid some drying, but at all stages steps must be taken to minimize this. If the trees are left lying about, are badly packed, or are heeled in without opening the bundles and spreading out the roots, then drying may occur. On the other hand, slight drying will not cause serious damage, and it is a mistake to over-estimate the importance of short delays in transit provided the trees have been properly packed.

The age and size of a tree is a very important consideration, especially as regards conifers. If the roots and foliage of a pine two feet high be compared with those of a pine nine inches high, it will usually be found that the larger tree has relatively smaller roots. Its chances of success must, therefore, be proportionately less. Further the larger tree is more likely to be blown by wind and the probability of survival further reduced. It is possible, also, that the degree of root activity is greater in the smaller tree. Hardwoods may generally be planted in rather larger sizes than conifers. Many deaths are due every year to faults in size.

In conjunction with the considerations already mentioned which may affect the survival of newly planted trees, due allowance must be made for the natural powers of re-adjustment inherent in a species or a specimen. The operation of transplanting creates a disturbance in the life of a tree which calls for a re-adjustment to the new conditions in which the tree is placed. Various species, and also individuals, possess this ability in differing degrees. In some cases interrupted root activity is slow to re-assert itself and to adjust itself to changed environment. One individual specimen may prove less able to make this adjustment than another. This does not necessarily imply a constitutional weakness in the tree so much as the presence of specific hereditary factors, and at present no means of entirely eliminating such traits has been found. The use of hormones is not so far a practicable proposition in the plantation, although this may come in time.

It will be seen that the problem of determining the cause or causes of death is not so simple a matter. Yet there is one more cause to be considered, and that is the "unknown" factor. There are definite indications which give one reason to believe that tree life is dependent upon certain conditions about which very little or nothing

is known. For example, there is much still to be learnt about soil bacteria and of those conditions which regulate their activity and effect on tree growth. It has been suggested that bacteria are affected by light rays from the moon and that plant growth is stimulated to a greater extent when the moon is waxing than when it is waning. It is quite possible that various electro-magnetic and other cosmic forces have a greater influence than we imagine on plant life, and probably these and other unknown factors make their contribution to the problem of failures in plantations.

Until such time as knowledge of these matters has been extended considerably, it must be recognized that losses among newly planted trees are due to causes some of which can be controlled, while others are just "blind chance."—*Quarterly Journal of Forestry,* Vol. XXXIV, No. 4, for October, 1940.

A CENTURY OF LIEBIG'S THEORY OF MINERAL NUTRITION OF PLANTS AND OF SOIL FERTILITY

By B. Wiswa Nath

(Imperial Agricultural Research Institute, New Delhi)

It is now a century since Liebig, the German Chemist, announced in the year 1840, his theory of the mineral nutrition of plants and soil fertility. The announcement is not only an important landmark in the progress of knowledge of the chemistry of plants and the science of plant nutrition and crop production, but is the foundation of Agricultural Chemistry as we know it to-day.

The history of science abounds with instances in which thought and research changed from time to time following discoveries of fundamental importance. Such discoveries, eventually directed experiment and thought into new fields, leading to new knowledge and expansion in scientific outlook, without at the same time invalidating previous knowledge and experience. Liebig's theory is an example in point. It will be interesting and instructive to briefly recapitulate the major developments leading to Liebig's theory and to review the experience and the trend of research and thought on soil fertility and plant nutrition during the century that has elapsed.

Till Liebig expounded his views in the year 1840, the "humus theory" of plant nutrition held the field and it was believed that plants should be nourished by a substance of a similar nature. Chemistry and Agricultural Chemistry as they are known to-day had their beginnings in the mists of alchemy. In those days the knowledge of the constitution of matter was only in terms of the four elements or primordial materials of the Aristotelian philosophy, *viz.*, fire, air, earth and water. Towards the end of the sixteenth and the beginning of the seventeenth centuries Paracelsus taught that life was a chemical process and that the bodies of animals and plants were chemical laboratories. The belief was held that compounds manufactured by life processes in the bodies of animals and plants could not be made in the laboratory.

The discovery of several chemical elements in rapid succession between the years 1750 and 1800 and the development of quantitative methods of experimentation by Lavoisier and de Saussure marked the beginnings of Agricultural Chemistry and the study of the chemical composition of plants received a powerful impetus. The synthesis of urea in the laboratory by Wöhler in 1828 was another step in advance. It finally disposed of the distinction between substances made by life-process in the bodies of animals and plants and those made in the laboratory. These developments opened up fresh fields of enquiry and led Liebig to turn his attention to plant chemistry. He made chemical analyses of the ashes of plants and manures, carried out experiments on a piece of uncultivated land at Gissen and discovered that by applying to the soil nothing but mineral salts he could turn the land into as fertile a spot as could be found in all Germany. He discovered that plants could absorb minerals and assimilate them and could manufacture their organic materials from air and water. He attributed the effectiveness of farm-yard manure to the mineral salts of phosphorus, potassium, sodium, calcium, magnesium and others contained in the manure and also found in plant ashes, dismissed the humus theory and announced his mineral theory of plant nutrition and soil fertility.

Although this announcement raised a bitter controversy in the beginning, its value was eventually recognised. Liebig, by analysis and synthesis of the then existing data, clarified the ideas on plant

nutrition, placed them on a scientific footing and simplified manuring of crops. A chemical analysis of the soil would indicate what was lacking or inadequate in it and the restoration of the lacking or inadequate element to the soil would restore its fertility. It was all so simple and easy, and therefore these ideas of chemical treatment of the soil rapidly gained favour. The use of artificial or chemical fertilisers became popular and a huge artificial fertiliser industry had arisen.

The earlier experiences in the practical application of the theory to the humus rich soils of the temperate climates of Europe gave such unqualified support to the theory that it was believed that artificial or chemical fertilisers could for ever effectively substitute farm-yard manure and other organic manures. The belief developed that farming might be only chemistry and a matter of supply of mineral salts to the soil. Plant nutrition came to be regarded as entirely a matter of direct mineral absorption and plant nutritional and agrobiological concepts have been developed and interpreted in terms of fertiliser elements.

Subsequent developments provided evidence that soil fertility was not quite such a simple matter as that. Towards the end of the nineteenth century discoveries, led by Pasteur, of bacteria and his studies on fermentation processes assumed a definite stage and shape, and threw light on the biological processes in the soil. and brought the realisation that in soil fertility there was something more than continuous supply of mineral fertilisers. About the year 1850 Pasteur pointed out that important changes especially oxidations are brought about by Micro-organisms. In 1877 Schloesing and Muntz and a little later Schloesing established the oxidation of soil organic matter to nitrates by bacteria. In 1888 Hellriegel and Wilfarth investigating the problem of nitrate supply and plant-growth observed that while gramminaceous plants failed to grow without nitrate supply leguminous plants could do so. This was ultimately traced to symbiotic nitrogen fixation. Towards the close of the century Knox, Winogradsky and others showed that atmospheric nitrogen was fixed in the soil by azotobacter.

The birth of the twentieth century saw the extension of the zone of soil and plant research to countries outside Europe and

America and included the hot, humid, and dry tropics. The increase in the number of research workers working under different conditions of soil, climate and crops soon widened the scope of enquiry. Gradually knowledge accumulated. The importance of organic matter and micro-organisms in the soil became apparent. Soil processes and the nitrogen and carbon cycles became clearer. Farmers and experimenters were puzzled by the fact that manures like farm-yard manure, relatively poor in mineral plant foods and in their availability, produced equally good and even better results than mineral fertilisers. The long period experiments at Rothamsted in England and at Pusa and Coimbatore in India showed that although in the earlier years mineral or chemical fertilisers could produce better results than farm-yard manure, their continued application tended to decrease crop yields compared to farm-yard manure and green manures. Mineral or chemical fertilisers began to find their place as immensely important but not all-important. The sustained and better action of the organic manures was, however, attributed to the better moisure-holding powers of the soil.

Then came studies on human and animal diets and the discovery of vitamins. Once again vistas were opened up. Workers in animal and plant chemistry began to find common ground. Such important characteristics as sexual differences and sexual reproduction and such vital functions as respiration in plants are recognised to be similar to those in animals in their fundamental principles. But, no such similarities were yet thought of in regard to the fundamental nutritional requirements of plants and animals. The role of organic matter on crop-growth was considered to be only indirect and the existence of accessory factors in plant nutrition similar to vitamins in animal nutrition were either not considered or disregarded.

Bottomley[1] and later Mockeridge[2] announced for the first time that extracts of fermented organic manures gave to plants certain growth-promoting substances which they called *"auximones"* and which they considered essential to plants. The hold of Liebig's mineral theory was still strong and Maze[3] just then showed by water-cultures the importance of trace elements for plant-growth. The views of Bottomley and Mockeridge were vigorously opposed and their results were explained in the light of Maze's results. Bottomley

died and Mockeridge in a later communication[4] even abandoned her former views on the direct effect of organic matter on plant-growth.

Nevertheless, the experiences in the field and in the laboratory compelled investigators to revert to this question on the effect of organic matter and manures on soil fertility and the work of the last two decades in India and outside has recorded notable advances and opened up new lines of thought and research.

The work in India of Viswa Nath,[5] McCarrison and Viswa Nath,[6] and Viswa Nath and Suryanarayana[7] has provided a complete picture and has thrown new light on the role of organic matter and micro-organisms in plant nutrition and on the inter-relationship between, and the inter-dependence of the three components of the system soil-plant-animal. These workers have shown that organic manures play a part hitherto unsuspected and that they provide certain substances analogous to vitamins which are absorbed and assimilated by plants leading to improvements into the quality of the end products of plant metabolism either as food or seed material. They have stated on the basis of their experimental evidence that:

1. Plants also have accessory food factors, akin to vitamins, for proper development and reproduction.

2. Organic manures have as one of their functions the supply of these accessory food factors.

3. There exists a cycle or chain of accessory factors beginning with soil micro-organisms and ending with returning to the soil through plant and animal bodies.

4. Nutritional factors for animals are associated with nutritional factors for plants.

These views which were published in 1926 not only did not receive acceptance, but even roused opposition due partly to their newness and the knowledge being incomplete and partly to the difficulties experienced on getting clear of the narrow view-points resulting from a too limited experience. In the few years that have elapsed more data have been obtained in different parts of the world in support of the views mentioned above.

At a discussion held by the Royal Society of London in the summer of 1937[8] the available information scattered in several publications was reviewed and it was recognised that the case established in

the nutrition of animals was equally established in the nutrition of the most diverse varieties of cells and that all cells from the lowliest bacterium to the cells of the highest animals carry out the series of reactions leading to the production of energy and growth by the help of substances mostly of the nature of vitamins in animal nutrition.

The isolation of *auxins*, substances concerned in the growth of plants, by Kögl in a crystalline form from urine, malt, yeast, liquid manure and farm-yard manure, and Kögl's observations on the existence of a cycle of growth factors in nature[9] provided further support to Indian work. The work of Thimman,[10] of Link[11] on the role of micro-organisms as factors in the regulation of plant processes; and the work of Link[12] and of others have provided evidence in support of the statement on the effects of organic manures and substances produced by microbial fermentation.

McCarrison and Viswa Nath[13] have drawn attention to another aspect of the subject. They have shown that manurial and fertiliser applications are capable of reacting on plants not only by increasing yields, but also by influencing the quality of the seed and by bringing about changes in the composition and nutritive value of the produce, and that in this respect the produce raised with mineral fertilisers on soils poor in organic matter is inferior to that raised with farm-yard manure. These observations find support in the results of work by Rowland and Wilkinson,[14] Thomas and Thompson,[15] Booth,[16] and of Howard[17] in England; Ysabel Daldy[18] in New Zealand, Tallarico[19] in Italy; Hunt,[20] Breazeale,[21] Thompson[22] in America; Kruger,[23] Kottmier,[24] Wachholder and Nehring,[25] Smallfuss,[26] and of Rudolph Berk[27] in Germany. On the other hand the results of Harris[28] in England, Schunert and his associates in Germany[29] do not support the view that fertilisers and manures influence the nutritive value of crops. In 1936-37 experiments were made in Germany under the joint auspices of the Association for Scientific Research, the National Board of Health and the Society for Nutrition Research. The nutritive value of vegetables grown with animal manure plus fertilisers were tested. On adults the results showed no definite effect. On children the results showed that vegetables grown with animal manure and artificial manure together were superior to those grown with animal manure only. In similar experiments in New Zealand by Chapman[30] vegetables grown

on humus-treated soil when fed to school children were found superior to vegetables raised with mineral fertilisers. There are thus two schools holding opposing views and the existence of these differences is the greatest stimulus for further investigation and elucidation.

Although our ideas have undergone changes and notable advances have been made since Liebig's days, the original theory is still valid. But the humus theory which prevailed a century ago is again coming into its own but in a qualified manner. The developments of the past century direct pointed attention to one important aspect, namely, the differentiation between soil fertility and soil fruitfulness. Organic manures and organic fertilisers build up and maintain soil fertility for artificial fertilisers to be fruitful. It is in the recognition of this truth lies the reconciliation of the opposing views. There is also the growing recognition that we are at the beginning of new knowledge and that workers in plant and animal nutrition may increasingly find common interests in the studies on cell metabolism. We are indebted for our present knowledge to the pioneers of the past and look forward to future developments which may give us more knowledge and control over soil fertility.

1. Proc. Roy. Soc. (B), 1914, **88**, 237.
2. *Ibid.*, 1917, **89**, 508.
3. Ann. Inst. Past., 1914, **28**, 21.
4. Ann. Bot., 1924, **38**, 723.
5. Jour. Madras Agric. Students' Union, 1926, **14**, 19.
6. Ind. Jour. Med. Res., 1926, **14**, 351.
7. Mem. Dept. Agric. Ind. Chem. Series, 1927, **9**, 85.
8. Proc. Roy. Soc. (B), 1937, **124**, 1; "Nature," 1937, 161.
9. Chem. Ind., 1937, **57**, 49.
10. Jour. Gen. Physiol., 1934, **18**, 23.
11. Bot. Gaz., 1937, **98**, 816.
12. "Nature," 1937, **140**, 507.
13. Loc. cit.
14. Biochem. J., 1930, **24**, 199.
15. J. S. C. I., 1938, **57**, 210.
16. *Ibid.*, 1940, **59**, 181.
17. Chem. and Ind., 1938.
18. "Nature," 1940, **145**, 905.
19. Mem. Acad. Ital. Boil., 1932, **3** (**1**), 5.
20. Ohio Exp. Stn. Ann. Rep., 1928.
21. Univ. Arizona Tech. Bull., 1927, **16**.
22. Proc. Amer. Soc. Hort. Sci., 1937, **34**, 599.
23. Landw. Jaharb., 1927, **66**, 781.
24. Kuhn. Arch., 1927, **15**.
25. Bodenk. Pflanz., 1938, **9**|**10**, 708.
26. Phytopath Z., 1937, **5**, 207.
27. Boden. U. Pflanz., 1939, **12**, **129**.
28. Biochem. Z., Jour., 1934.
29. Biochem. Z., 1934—39.
30. "Nature," 1940, **145**, 905.

—*Current Science*, Vol. 9, No. 12, dated December, 1940.

SOIL EROSION IN THE TROPICS

BY ROBERT L. PENDLETON

Advisor to the Government of Siam

Because of important differences between humid tropical soils and those of temperate regions, the necessary differences in their management are not at once apparent to the soil scientist whose training and experience have been obtained exclusively in the temperate zones. In spite of the importance of lowland rice, too often a soil scientist from the temperate Occident passes over the question of lowland rice soils with little more than the mere remark that such soils are waterlogged, the presumption being that because these soils are exceptional from the standpoint of normal temperate zone agriculture, they are hardly worthy of further consideration. The differences of soil science background and training make it difficult for the tropical soil scientist, when writing about soil conditions in the tropics, to make the subject clear to those who have not had the good fortune to gain first-hand knowledge of tropical soils. Even so it may be worthwhile briefly to describe and contrast certain soil conditions and phenomena in several tropical countries; the Philippines, Siam, China, and India. These last two countries are not properly tropical, but it has been my good fortune to have studied soil and agricultural conditions in certain portions of these countries, and it is hoped that the following remarks will be of interest. Attention is called to certain of the scattered papers, particularly in less well-known publications, which refer more or less directly to soil erosion and to the methods of reforestation particularly suited to the humid tropics. Certain general observations, which have not previously been published, have also been included. In several of these countries, in British India particularly, a large and continually increasing amount of excellent detailed soil research is being done. But there are still lacking sufficient adequate descriptions of soils and soil conditions as a whole to give a satisfactory general picture of the soil and agriculture of the entire region.

In the humid tropics and subtropics the kinds of soils, as well as the nature and rate of erosion, frequently differ markedly from the soils and soil conditions that prevail in other climatic regions, in spite of the fact that throughout the world the same physical, chemical, and biological laws hold true.

There are at least four reasons for these notable differences: (1) the almost continuously higher temperatures of the tropics, modified more by altitude than by anything else; (2) the intensity and distribution of the rainfall during the year; (3) the character of the native vegetation and its reaction to man's activities; and (4) the growth of the most important food crop, lowland rice, in paddy fields artificially submerged for a considerable part of the year, within low dikes.[1]

---

[1] Those of us who have been long in the tropics, and fully realize the importance of studying submerged soils, feel handicapped, and so often unable to go on because the conventional methods of studying soils break down when applied to padi soils under normal conditions. We have not been clever enough to devise suitable methods adapted to submerged soils.

First, let us consider some features of the soils and vegetation which humid tropical regions have in common. As Mohr (*8, 9*) and others have repeatedly suggested, the original vegetation on normal subaerial soils in such regions was tropical high forest. The total amount of organic matter produced annually by such a forest at low elevations in the humid tropics is very great (*9, 28*). But as a result of the activities of micro-organisms, fungi, and termites (under almost all conditions) the dead organic matter disappears rapidly, so that on the forest floor there is seldom any appreciable amount of leaf mould, forest litter, or other partially decayed material. The potential rate of decay of organic matter is greater than that of its formation. There are wide differences in the fertility of tropical soils. Often the apearance of the tall, dense luxuriant forest gives the impression of a much greater fertility of the soil than is actually found to be the case after the forest has been cleared and used for annual or relatively shallow rooted plantation crops. For, once the forest is cleared the surface accumulations of organic matter are no longer continually replaced; the cycle of plant foods drawn from deeper and weathering rock is broken.

Furthermore, forest fires seldom occur in the humid tropis tropical lowlands, although annual grass fires of adjacent cogonals or artificial savannas may, in the course of years, gradually force back the edge of the forest. In most cases, tropical forests appear able to make remarkably quick recoveries.

The large amounts of precipitation in the humid regions, and the abundant opportunity for it to take up carbon dioxide from the rapidly decaying organic matter on the forest floor, together with the continuously high temperature, are important factors in the very deep weathering of the rocks of the tropics. For these reasons it is rarely possible in many regions to find unweathered formations at or near the surface. The highly weathered condition of the underlying rock makes it possible for erosion, once it gets through the surface protection, to do great damage (*24*).

The textures of tropical soils differ markedly from those of many temperate regions, where loams are of frequent occurrence. In the tropics the textures are usually either sandy or fine sandy loams or clay loams or clays. True loams are very unusual. There

is the probability that excellent crumb structures of heavy textured soils will deceive the temperate-zone-trained person. The red clay upland soils of Chantaburi, Siam, are easily cultivated into an excellent mulch within an hour of the falling of an inch of rain.

In most tropical countries there is a considerable cultivation of recently cleared, unterraced hilly and mountainous forest land. This cultivation is carried on because of racial or tribal custom or habit, of military or economic pressure, or the research for better soils, which has forced certain groups back into the forests in the hills and mountains. At times it is because of the desire to raise special varieties of crops, particularly prized for quality, such as upland unirrigated rice in the Philippines, which is produced only with considerably greater labour and trouble solely for home use.

Shifting cultivation of forest clearings seems to be practised throughout the humid tropics of the world. It is known by different names in different regions: Caingin in the Philippines, tam rai in Siam, *taungya* in Burma, *ladang* in the Netherlands Indies, and *cheena* in Ceylon. The practice is usually the same: the forest is cut down at the commencement of the dry season; the large trees may be lopped off high above the ground to eliminate shade and still avoid the heavy labour of felling. All the brush and most of the timber are burned before the rains commence, and no attempt is made properly to clear the land of logs and stumps. The surface of the soil is often friable and loose, the result of lying exposed to sun and rain.

Upland rice, maize, or other crop is planted in shallow holes made a few inches apart. Preparing the holes is done with a long dibble or bamboo pole, at times cleverly designed to have the proper-spring and noise-making charactertistics to facilitate the flicking of the earth from the holes, and at the same time to add to the picnic spirit of communal planting. In each shallow hole (1-2 c.m. deep) made by the dibble a few seeds are dropped, after which the barefoot planter with his toe pushes a bit of dirt over the seed to cover it. Upland rice, vegetables, maize, or cotton may be grown. As the growth progresses, some weeding may be done, but there is no real cultivation of the soil. From one to three crops—one summer, one winter, and possibly a second summer crop—may be grown before the weeds get well established and the surface soil so hard that it

can no longer be planted by the hand or dibble methods adapted to these conditions.

Caingin agriculture is a very considerable factor in soil erosion. For after the forest is cut and burned toward the end of the dry season, the soil is left loose, friable, and exposed to the sun. Often the early rains are torrential, and the loose, friable granular clay loams wash off like sand before the crop is planted, or at best before it is old enough to protect the soil. If the clearing is allowed to grow up to forest, weeds are eliminated in a decade or so; the soil is rejuvenated and is ready for another cultivation, to complete another rotation. This type of farming is a long-time rotation, with the forest as the cover crop; it is the system of cultivation employed for the production of the best wrapper tobacco leaf in Sumatra (*9*). When the "caingining" is more intensive, and clearings are contiguous and the weeds, grass, and young trees are burned annually, there develops an artificial savannah, a cogonal, of cogon (Imperata sp.). This cover is usually burned annually and prevents the re-establishment of the forest. Under these conditions rill or gully erosion does not often develop seriously, but landslides occur in places.

Caingin agriculture probably was an important factor in the downfall of Angkor. In the absence of suitable plows for effective deep cultivation, caingin methods of agriculture were employed for producing all upland crops, i.e., all but lowland rice or other crops which grow in puddled or flooded land. And much of the land, even in the humid tropics and particularly in Cambodia, is not well enough watered naturally to produce rice or other lowland crops. Hence an increasing pressure of population would increase the frequency of the rotation. Less and less opportunity was given the native forest to conquer the cogon grass and other weeds. All the while the annual burnings accentuated the development of cogonals, until the entire upland was one vast cogonal, no longer capable of supporting a caingin agriculture. There are now vast savannas, almost certainly artificial, in Cambodia and particularly in the Angkor region. It is not at all likely that the Khmers had plows capable of plowing the cogon and similar grass lands, so that food producing areas were decreased in the face of increasing populations. Such a reduction in food producing lands may account for a marked

weakening of the resources of the very rich and highly developed civilization of Angkor, from the 10th to the 12th century, A.D.[2]

Farmers are glad to clear forest land for a crop or two, and in return for the use of the land to plant useful forest trees along with their crop, and to care for the crop and the trees as long as they occupy the caingin. Accordingly, caingin cultivation has been used effectively by foresters for the elimination of worthless forest. With protection against fire, such plantations develop into good stands of valuable timber.

For the most part, the lowlands in the humid tropics are occupied by padies, planted to lowland rice during the rainy season. For the raising of most varieties of this crop it is necessary carefully to level and dike the fields, usually in small units of a fraction of an acre, so that the level of the water can be easily maintained properly. Unless there is some special source of irrigation water, usually in the upper portions of the valleys and their side slopes or near the tops of low elevations, lowland rice cannot be grown, for this crop must usually have considerably more water than falls directly on the land as rain. The padies are cultivated when the soil is under water, and the process is continued until the puddled soil is a thick gravy. At this cultivating and planting season there may be considerable water flowing over the padies from the hills, hence the water running out of the padies and off into the streams and rivers is often muddy. There may thus be a considerable loss of clay in suspension in the water flowing off from the padi during and after the puddling of the soil and the transplanting of the rice seedlings, yet this method of cultivation quite precludes all the customary types of erosion. In this form of erosion it is the finest clay which is carried away; somewhat less fine material is left behind in the padies. In a sense this might be called differential soil erosion. The cultivation year after year of the saturated, submerged soil also tends to separate the upper portion of the soil into the sandier surface fraction and a much more compact, heavier textured horizon as the plow pan. The padies are obviously also useful in catching and re-

[2] Dr. H. N. Whitford, an authority in tropical forestry having had repeated opportunities of studying the Angkor region from the air, concurs in this explanation. He also suggested that the Maya civilization of Central America died out because of the same reasons.

taining soil washed from the hill slopes along with the water to be used for irrigation. When only a little silt is carried into the padies the effect may be good, but, if the erosion on the hills be excessive, the quantity of sediment deposited on the padies may be so large as to injure or completely destroy the usefulness of the land for growing rice.

In some portions of the Mountain Province, Philippine Islands, where there has not been enough naturally flat irrigable land for rice cultivation for food for local use, enormous effort has been expended by the mountain tribes in building stone walls and moving earth to make terraces for holding soil and water for lowland or padi rice production. Such made-land is so scarce that erosion has had to be prevented. In Java the relatively deep volcanic soil is terraced far up the mountain slopes, and erosion is carefully prevented.

The pasturing of cattle has markedly different effects in the humid tropics than it has in temperate regions. In the tropics erosion of pastured land is seldom serious for the cattle are usually unable to keep ahead of the vegetation, so that in maintaining pastures it has often been found necessary to employ considerable hand labor to keep the brush, especially the less palatable sorts, cut, and so to permit the satisfactory grasses to grow for pasture. Of course, where cattle are concentrated in narrow lanes, particularly on steep slopes, there is certain to be some erosion of the paths. Suitable browse shrubs or low trees are needed for tropical pasture land to draw added nourishment and moisture from the deeper portions of the soil, and to protect the surface against erosion. A discussion of this question would be mostly speculative, however, for pasture development and maintenance in the tropics, together with their whole series of problems, are subjects as yet practically untouched.

The cultivation of Hevea rubber in certain tropical countries has been notorious for the serious amount of soil erosion caused by the formerly extensively practiced method of rigorous clean cultivation. In the Philippines most of the plantings are on a plantation scale (16, 18). In Siam, except for a very few plantations under European management, the Hevea is densely planted, almost entirely in small plots, owned by natives, Because of the usual abundant weed and brush undergrowth and the absence of thorough clearing

of the forest, the soils of Siam's rubber plantations have not eroded seriously even though most of the plantings are on low hills and sloping lands. These seemingly careless plantation methods have markedly conserved the soil. Furthermore, the actual per acre yield of rubber from such plantations is good.

Let us now compare the topographic, tectonic and geological features which to a greater or less degree affect soil character and the tendency toward erosion in the several regions.

THE PHILIPPINE ISLANDS

The Philippines are young geologically and tectonically unstable, with many still loose volcanic soils and much topography with rough to steep slopes. The soils as a whole are fertile. Catastrophic erosion in places is serious. Because of the general youthfulness of the country, the continuous normal erosion of upper slopes, and the resulting aggredation of the plains, with changes of elevation or relative position of sea and land, it has been practically impossible to find well-developed laterite. Most of the rivers are short, with steep gradients, and flow rapidly into the sea, carrying with them a vast amount of material eroded from the land surface. Consequently, in spite of the dense tropical vegetation, which still covers much of the land surface, there is a great deal of erosion. The heavy rainfall, and the steep, deeply weathered mountain slopes cause landslides on a large scale, and these contribute a considerable proportion of the load carried and moved by the rivers (17, 18).

The more or less unconsolidated fragmental volcanic deposits have also been subject to serious erosion. The streams sometimes cut deep and precipitous gorges down into the soft tuffs, and the loose volcanic ash at times washes seriously. Once in the Bicol region during a very heavy rain, an almost level area of many hundreds of hectares of soil and unconsolidated volcanic ash became saturated and without warning suddenly slumped out, to a depth of from 5 to 25 meters, and caused much loss of life and destruction of property (15).

In some parts of the Mountains Province near the tops of the ridges and on the upper slopes, where unirrigated crops are grown, it is customary to throw up an earth wall, with the ditch on the outside, for protection against wild pigs and other animals. Such a ditch may concentrate enough water flowing down over the slope outside of the protected field to start serious gully erosion (20).

On the islands of Negros and Luzon the cultivation of sugarcane, sometimes on rather steep slopes, with the furrows often running up and down the slope, has been the cause of erosion so serious that the practicable useful life of these soils cannot be much more than a decade. On some of the lower lands drainage ditches in cane fields have grown enormously (11, 13). Much of the surface of the island of Cebu, which has the densest population of any island in the archipelago, is rough and steeply sloping (18). The friable black clay residual surface soil has been developed from a veneer of coralline limestone which covers most of the island. The natives of this island are maize eaters (they cannot grow padi rice on this soil). They have "caingined" the steep slopes to grow maize, and often have continued to cultivate until the soil has been entirely eroded away, leaving exposed the whitish coralline rock. The Insular Bureau of Forestry demonstrated that these eroded slopes could be reforested, the soils improved, and erosion markedly retarded by the use of *Leucaena glauca* and other shrubs and trees. But the pressure of population was too great, the reforested areas have been "caingined" again, and erosion continued.

Coco palms and fruit trees are seldom maintained as clean cultures; more often they are grown as very brushy or mixed cultures of various crops together. Erosion seldom occurs under these conditions. Abaca (*Musa textilis*) grows as forest under shade of big forest trees.

SIAM

Siam, a very different country from the Philippines, is tectonically stable, particularly in the central portion, and the surface topography as a whole is nearer stability. The central plain of fertile clay rice soils is surrounded by low undulating plains of erosion or aggradation, and less fertile soils with laterite common in the deeper horizons. There are hills and mountains, though generally they are less precipitous, and consequently erosion is less, than in the Philippines. The higher mountains of the country are batholits of acid magmatic rock. The originally overlying deformed sedimentary materials have been largely eroded away. Here and there Permocarbonate limestone bluffs tower above the plains or slopes. The north-eastern portion, usually known as the Korat Plateau, is composed of mostly

autochthonous fine sandy loams on Tertiary red sandstone, with a slightly undulating to nearly flat topography. In Northern Siam there are hills, steeply sloping in places, of sedimentary and granite rocks. There are no known volcanoes, though in widely scattered localities there have been some extrusions of basic magmatic rock, now weathered to friable, red clay soils.

The interior of central, northern, and north-eastern Siam has a long dry season, and for a considerable period each year the relative humidity is low, so that the effects of the arid months are accentuated by senile and consequently infertile soils. In this region the more or less open, lower, poor forest has a considerable percentage of trees with very hard, durable wood.

Accelerated erosion does occur in Siam, but it is hardly evident over most of the country, and in general it is not a serious problem. However, from the usually muddy condition of the main rivers flowing out through central and north-eastern Siam, we know that somewhere erosion must be going on. As Credner (2) has noted, the lower courses of the main rivers are at base level, and the streams are only gradually building up natural levees along their banks, and slowly extending their deltas out into the Gulf of Siam. Thus there is practically no erosion in the central plain, except a certain amount of channel scouring along the river banks, aggravated by the wash caused by power boats. Considerable portions of the land above the flood plain of these rivers are gently sloping or slightly undulating plains of erosion, about at equilibrium and clothed with a scant, open forest. These plains have taken the place of the sedimentary and metamorphic rocks which have been weathered and eroded away. Practically no material is eroded off from these plains, but much of what does erode from the slightly elevated portions is caught in the rice fields which occupy the lower portions of the terrain, where enough rainfall can be collected and retained to grow a crop of rice in a favourable year. That these undulating plains have been about at equilibrium for a long time is indicated by the laterite which has developed in the soil profile and which now so generally occurs in the older soils of Siam. While usually the laterite occupies the normal position of the illuvial horizon in the profile, occasionally it has been exposed by erosion of the surface soil, and lies as hard sheets of an

acre or more; or may be found as blocks scattered about on the surface, likely as the result of lifting by roots of trees blown over by the wind.

A similar condition, not quite so near to equilibrium, is common in the smaller plains along the eastern side of the granitic mountain ranges of southern or peninsular Siam. Shore deposits and the associated lagoons, the opposite of erosion, have added considerably to the land area. In Phuket Island, and elsewhere in southern Siam, serious erosion, fortunately localized, and transport of silt from placer to lode tin mining have ruined rice fields and silted up rivers. Phuket Bay, too, is nearly filled.

It is in the more steeply sloping mountains of northern Siam where the sedimentary rocks are frequently exposed near the suface, and where the natives, particularly certain of the hill or mountain tribes, practice caingin or *tam rai* types of agriculture, that the most erosion must occur from which the main rivers receive their load of mud. Teak logging on the better forest soils along the lower slopes of the hills and mountains, and in the narrow creek beds, also contributes its share to soil disturbance and so to muddy rivers.

Often where there is caingin cultivation of the steep hills in Siam, there may be a dense growth of grass and brush in the bottoms of the narrow valleys. This growth helps retain the wash from the sides of the valleys, but, where the valleys are wider, the bottoms are almost certain to be occupied by lowland rice fields, or padies.

Although there are a few examples of nearly clean-cultivated fruit orchards on sandy soils residual upon granite, which erode seriously, most of the fruit trees growing on slopes steep enough to erode are planted and managed as forest growth rather than as orchard. Once a year the underbrush is slashed, but there is no cultivation or other disturbance of the soil, and hence no erosion except for a little along the steeper paths. But the most important fruit gardens in Siam are around Bangkok, where the soil is normally low and saturated with water for many months annually. In order to provide aerated soil for the tree roots, the soil is heaped up into long ridges, about 3 meters wide by 1.5 meter high. Between the ridges are broad ditches with gently sloping banks. Even though the soil of these ridges is mulched, there is erosion into the ditches;

this is offset by the annual cleaning and deepening of the ditches, from which the mud is thrown upon the ridges about the trees.

During flood the rivers of central Siam in many places flow out over their banks, and the muddy water gradually passes out through the fields of deep water rice. In this region the country is almost level for great distances. For many kilometers there are practically no dikes to restrain the water on the land, and the whole plain is like one large rice field, with the water between 1 and 2 meters deep. Before the water rises special varieties of deep water rice are sown broadcast in this plain. As the water slowly flows through the growing rice across these fields much of the material in suspension settles out, so that when the water reaches the next lower canal or distributary of the river, it comes out into the channel nearly clear and quite dark coloured, having lost much silt and clay, and having taken into solution some organic matter. Thus the level of the plain is gradually being raised. The colouring matter in the water and the remaining suspended matter, as well as the bottom load of the rivers, are carried on to the Gulf of Siam to increase the delta deposits, held in place by the mangroves, nipa palms, and other coastal swamp vegetation. Along the bonks of the rivers the dense growth of fruit trees and annual crops, as well as Sesbania and aquatic plants, help to protect and hold the river bank soil during floods.

CHINA

China, as is well known, has a great variety of climates, geological formations, and human and other factors which have affected the soil and which play a part in soil erosion. Although China is tectonically relatively stable, and there has been no volcanic activity in recent times to scatter loose efflata over the surface, yet erosion in China is considerable and serious. So much has been written about soil erosion in China that it might seem presumptuous to attempt a general brief statement, particularly since the conditions differ so widely in various parts of this great and varied country. In this paper it is impossible to do more than mention a few points relating particularly to southern China where the conditions are more closely related to the tropical regions just discussed. Manchuria has been briefly mentioned because it is a region, the soil erosion of which has received almost no attention.

The most striking and best known examples of soil erosion in China are the loess regions and the denuded rocky hills and mountains in central, north, and northwestern China. But with the descriptions and illustrations available in numerous papers by Lowdermilk (*7*), Cressey (*3*), Moyer (*10*), Thorp (*27*), Hou et al (*6*), Barbour (*1*), and Pendleton and co-workers (*21, 22*), it is hardly necessary to go into detail. During the past few years the results of the loess erosion have been very evident in the floods of the Yellow River, when that stream has filled its channel with sediment and repeatedly topped the dikes. But what else can be expected of a river which, at times, carries almost 50 per cent. of silt in its water, and whose speed changes from that of a rushing torrent in the mountains to that of a slowly flowing river where it crosses the plains?

Northern Manchuria is a region far removed from the tropics, but there too, in the short, hot, humid summer are grown semi-tropical crops. As has been pointed out (*23*) after deforestation, erosion of the shallow soils is very serious in its removal of the shallow surface horizon, and rapidly ruins many of the soils for agricultural use.

But it is in coastal and southern China, roughly from Hangchow and the Yangtze Rivers south to, and including the Liechow Peninsula, where the much more humid climate and the higher prevailing temperatures, as well as certain pre-Chinese traditions relating to forestry, and the different geological formations, make the erosion picture very different from that which it is usually supposed to be. In Kwangtung Province, where I have had the opportunity of studying soil conditions in some detail (*14, 19*), about 90 per cent. of the surface is too steep and rough to be suitable for continuous agriculture, so that probably through the process of "caingining" it has been deforested and converted into cogonals (artificial savannas of Imperata) and bracken. These savannas in many places extend to the tops of the mountains, which may be as much as 2,000 meters high, and the dense growth of grasses to a considerable extent prevents erosion from developing to a serious degree, though in places landslides are important. But in some localities, particularly in the interior, the Chinese regularly practise forestation, and plant and raise Chinese fir (*Cunninghamia lanceolata*) for poles and timber (*4, 19*). Cassava is used as a nurse crop for the first few years to protect the young

trees. At lower elevations and near the sea *Pinus massoniana* is grown extensively for fuel and timber. In tragic contrast to these appropriate local forestry methods, the great injury, in place of benefit, of supposedly modern temperate zone methods in forestation has been all too strikingly shown on the new campus of Sun Yat Sen University, Canton (*24*) where there is appalling soil erosion in new plantings.

The idea of encouraging forestry is widespread in central and southern China, and many forest nurseries have been established by local governments. The laudable aim is to raise trees for distribution and for development of forests. Unfortunately, however, these nurseries of several acres each, laid out on sloping or hilly land (practically all the flat land must be used for rice and other food crops) with their paths running up and down the slope, are from the standpoint of soil conservation of the worst possible design—erosion is often serious.

In Hong Kong, as many a traveller has noted, the granitic rocks are very deeply weathered and the soils if unprotected erode seriously. The marked beneficial effect of reforestation in this colony is also evident and it is a pity that this work has not received better financial support. Similar deeply weathered granitic rocks occur in many parts of Kwangtung Province, and in many a small valley the padies are prevented from being ruined by a flood of sand only by elaborate diversion ditches to take the wash from the eroding hills. Rivers, too, are choked with sand, so that the earlier-used efficient cargo boats have had to be replaced by flat, boat-shaped rafts of bamboo fitted with mat shelter and sail, which with the light loads possible, have a very shallow draft. This recalls Lowdermilk's (7) description of rivers farther north. The unfortunate erosion which results from plowing up the grass cover on the sandy soils from granite has been demonstrated all too clearly at Chungsham, north of Macao.

The Liechow Peninsula is made up principally of only slightly consolidated silicious sediments, doubtless derived from the same granitic massif to the north within the mainland (*14*). These have given rise to sandy soils. Subsequently there came to the surface basic igneous rock which has weathered to a red clay. Both have been

subject to erosion, the sandy soils to a much greater extent than the red clay. Being poor in plant food materials, this sandy soil cannot support a good vegetative cover, and is, naturally, seriously exposed to erosion, which is taking place.

The farmer in the Canton region too often thinks of irrigated padi land agriculture as the point of departure for all agriculture, and, like the Bangkok fruit grower, plants fruit trees upon ridged-up or heaped-up soil of former low wet rice fields, so as to get at least some well-drained soil for the tree roots. But when the Cantonese farmer does use the steep hill slopes for fruit growing, he usually fails properly to terrace the land, with resulting disastrous erosion.

In many parts of central and southern China, hills near the densely populated plains are made to supply all possible fuel for domestic use. Not only are grass and shrubs cut for fuel by the farmers, and during slack agricultural seasons carried to the cities and sold by the pound, but very often even the roots of the shrubs and trees are dug out for fuel. Particularly in Kwangtung, the cutting of bracken ferns for fuel is important. Naturally, such treatment has left the surface of the hills and mountains so long without proper vegetative protection that there is often not much soil left on the parent rocks. The more friable granular soil residual upon limestone hills in certain parts of Kwangtung has the sooner disappeared, with now vast expanses of bare rock exposed.

INDIA

India is also a vast region, having a great diversity of conditions which affect erosion. While the portions of central and northern India with which I am familiar by no means belong to the humid tropics, it may not be put out of place to discuss briefly some of the features.

Peninsular India is relatively stable tectonically, and is, for the most part, of very old geological formations, with a very much less rugged topography than have the mountain regions to the north, the northwest, and the east of the Indo-Gangetic alluvium. In peninsular India granitic rocks, silicious sandstones, and the enormous areas of the basic igneous Deccan Trap are the most important. In this part of India locally, especially near rivers, erosion is serious on the soils and secondary deposits derived from those rocks. The

geologically much younger, more rugged, Himalayas and the other ranges on the borders of India are eroding more rapidly. This erosion, in part probably normal, is due to the steepness of the slopes and the nature of the geological formations but, as Gorrie says (5), much of the erosion is due to the unrestrained activities of the natives in improper methods of farming steep slopes, and in excessive pasturing of cattle.

The rivers flowing out from the Himalayas and other ranges for a long time have been carrying enormous quantities of eroded material. This has built up a vast alluvial plain, extending out to and in between the northern hills of peninsular India. From these latter, lower ranges the Chambal, Sindh, Betwa, Ken, and Son Rivers flow. Their former flood plains coalesce with the main Jamna-Ganges flood plain. But now these rivers, particularly, the Jamna, and consequently the tributary Sindh, Chambal, and Betwa have cut their beds down into their unconsolidated deposits from 5 to 10 to as much as 30 meters below the general level of the plain. The result is that ravine erosion has cut back severely into the former flood plain deposits, and so ruined much of the upland plain for agriculture, even far back from the rivers—and more land is being eroded every year. As has been observed in China and elsewhere, cart tracks and country roads are often the start of serious ravine erosion extending back into the fields.

Some decades ago the Indian Forest Department commenced experimenting at Etawah near the Jamna River, in the United Provinces, on the possibilities of stopping this type of erosion and making the ravines useful. The land was protected by fencing, the steep slopes and many irregularities cut down by digging and plowing, earth dams with ingenious spillways were placed across the bottoms of the ravines, and suitable trees were planted—babul (*Acacia arabica*) on the upper, drier slopes, and shisham (*Dahlbergia sissu*) in the moister, lower places. Smythies (25) has fully described methods and the results, and I can testify from personal study that Smythies' descriptions are not exaggerated.

This work attracted the attention of Maharaja Scindia of the neighboring State of Gwalior, whereupon I was made member of a commission to study the whole question of erosion and methods for its control applicable to the extensive and seriously eroded ravine

country along the Chambal and Sind Rivers of that state. We spent six weeks travelling on horseback through this region, where hundreds of square miles of formerly good land have been completely ruined for agriculture because of ravine erosion. As already described (12) the commission recommended a scheme essentially the same as that which Smythies described; subsequent reports of the work in Gwalior State indicate that the method there is likewise successful.

As far as I know, there has never been an adequate survey of the eroded lands of the Indo-Gangetic plain as a whole. But judging from our detailed study of the conditions along the Sindh and Chambal Rivers, and elsewhere in Gwalior State, and from the enormous areas of eroded, ravine land which I observed during a trip by air across India in 1935, I believe the total loss of agricultural land in these regions of intense human and livestock population pressure must be enormous.

As Stewart (26) and others have mentioned, Smythies found that the main problem was the exclusion of livestock, both cattle and goats, from the eroding area. Tramping the soil hard, and cleaning off practically all the vegetation, livestock exposes the land to the torrential rains of the south-west monsoon. To a great extent the most important single agricultural problem in all that part of India is the cattle problem; cows are sacred and will not be "liquidated" by the local population. The problem of feed for them is so serious that during the long dry, agricultural idle season many people use *kurpies,* chisel-like trowels, to cut off from roadsides and other waste land the short weeds and grass sod which cattle and goats cannot readily browse directly. Obviously this practice exposes the soil to more serious erosion. Then the sod scrapings are shaken free of earth and fed to the miserable cattle. All the manure is collected, mixed with any additional available leaves and straw, formed into cakes, dried in the sun, and used as the only source of domestic fuel. Is it any wonder that the land erodes, that the fields become poorer, and that the lot of the peasant farmer does not seem materially to improve?

SUMMARY

Attention is called to the fact that occidental, temperate zone training is inadequate foundation for the proper appreciation and interpretation of tropical soils and for their management.

In view of their great importance, lowland rice or padi soils have not received the attention they deserve as an almost distinct field of study.

Upland or caingin agriculture, as carried on by the natives in the humid tropics, involves a distinct series of problems. In a sense this type of agriculure is a rotation in which the native forest is the cover crop. The methods employed in caingin agriculture are briefly described, to show the relation of this practice to soil erosion, and to show the ultimate result of pushing caingin agriculture to the extreme.

The importance of padi cultivation, in its various types, to soil erosion and to soil conservation is pointed out.

Accelerated erosion in the Philippines is ascribed to tectonic instability and the resulting steep slopes, to the loose volcanic deposits, and to the intense cultivation of particularly friable soils on steep slopes.

Siam, with tectonic stability and in many regions erosion and aggradation about at equilibrium, does not have serious erosion except in some of the northern hills and in the tin mining regions. Because of native methods, Hevea rubber cultivation has not generally suffered from soil erosion.

China, because of the pressure of population upon limited agricultural land, is suffering from catastrophic erosion in various regions. The type and amount of erosion differ markedly depending upon the nature of the rocks, the depth of weathering and the kind of soil resulting, and the nature of the present cover, which is related to the forestry practices. Temperate zone forestation methods have proved particularly ill-suited to South China.

In India there are two groups of serious erosion problems, caused (1) by the pressure of human and cattle populations upon steeply sloping mountainous land, and (2) by the change of base level and gullying of the elevated plains along some of the rivers of the Indo-Gangetic plain. This latter condition is markedly aggravated by the pressure of the cattle population, and by the associated utilization of the dung for fuel.

LITERATURE CITED

1. Barbour, G. B. 1930. The loess problem of China. Geol. Mag. 67: 458-475.
2. Credner, W. 1935. "Siam" Mit 27 Figuren in Text, 1 Tabelle und mit 12 Karten und 70 Bildern auf 32 Tafeln. 422 pp. Munich.
3. Cressey, G. B. 1934. China's geographic foundations. 436 pp., 197 *illus.* *McGraw-Hill Book Co.*, New York.
4. Fenzel, G. 1929. On the natural conditions affecting the introduction of forestry as a branch of rural economy in the province of Kwangtung, especially in North Kwangtung. Lingnan Sci. Jour. 7: 38-98, illus.
5. Gorrie, R. M. 1937. Economic importance of changes in plant cover. Jour. Indian Bot. Soc. 16: 209-216, illus.
6. Hou, K. C., L. C. Chu and L. C. Lee, 1935, A soil survey of Tinghsien, Hopei Province. National Geol. Survey of China. Soil Bull. 13. 63 pp., illus.
7. Lowdermilk, W. C. 1937. Sand rivers of China, Soil Conservation. 3: 1-4, 26, 27.
8. Mohr, E. C. Jul. 1933. Tropical soil forming processes and the development of tropical soils. 200 pp. English translation by Robert L. Pendleton. Nat. Geol. Survey of China, Peiping.
9. Mohr, E. C. Jul. 1933. De Bodem der Tropen in het Algemeen en die van Nederlandsch-Indie in het Bijzonder. Koninklijke Vereeniging Koloniaal Instituut, Amsterdam. (Five parts of the projected six have thus far appeared. An authorized English translation is being done by Robert L. Pendleton).
10. Moyer, R. T. 1935. Soils of Shansi Province. Nat. Geol. Survey of China. Soil Bull. 10, 60 pp., illus.
11. Pendleton, R. L. 1925. The drainage of cane lands in the Philippines. Sugar News 6: 621-631, 720-728.
12. Pendleton, R. L. 1930. Ravine reclamation in Gwalior State, Central India. Makiling Echo. 9: 25-32.
13. Pendleton, R. L. 1931. A soil survey of the La Carlota area, Occidental Negros, Philippine Islands. Soil Res. 2: 308-343, illus.

14. Pendleton, R. L. 1933. Cogonals and reforestation with Leucaena glauca. Lingnan Sci. Jour. 12: 555-560; 8 figs.

15. Pendleton, R. L. 1934. The Bicol Region. Philippine Agric. 23: 247-252.

16. Pendleton, R. L. 1935. Rubber forestry. Sugar News 16: 7-15, illus.

17. Pendleton, R. L. 1935. Erosion of agricultural soils in the Philippines. Sugar News 16: 237-248, illus.

18. Pendleton, R. L. 1935. Glimpses of hinterlands in the Southern Islands: Zamboanga, Jolo and Cebu. Philippine Agric. 23: 823-832.

19. Pendleton, R. L. 1937. Forestry in Kwangtung Province, South China. Lingnan Sci. Jour. 16: 473-480, illus.

20. Pendleton, R. L. and D. I. Aquino. 1932. Soils of Bokakeng Forestry Management Project, Baguio, Mountain Province. Philippine Agric. 20: 500-510, illus.

21. Pendleton, R. L., L. C. Ch'ang, W. Chen and K. C. Hou, 1932. Soil survey of the Salachi Area, Suiyuan Province, China. Natl. Geol. Survey of China. Soil Bull. 4, 43 pp., illus.

22. Pendleton, R. L., L. C. Ch'ang, W. Chen and K. C, Hou, 1935. Soil survey of the Tatung Area, Shansi Province, China. Geol. Survey of China. Soil Bull. 5, 23 pp., illus.

23. Pendleton, R. L., L. C. Ch'ang, W. Chen and K. C. Hou, 1935. A reconnaissance soil survey of the Harbin Region. Natl. Geol. Survey of China. Soil Bull. 11, 134 pp., illus.

24. Pendleton, R. L. and H. M. Curran. 1935, Preventing soil erosion in forest nurseries. Lingnan Sci. Jour. 14: 439-443, illus.

25. Smythies, E. A. 1920. Afforestation of ravine lands in the Etawah District, United Provinces. Indian Forest Rec. 7: 217-249.

26. Stewart, G. R. 1937. The Punjab plans a co-ordinated attack, Soil Conservation 3: 14-17, 21.

27. Thorp. J. 1936. Soil erosion in China. Jour. Assoc, Chinese and Amer. Engineers 17: 183-210, illus.

28. Vageler, P. 1933. An introduction to tropical soils. xvi plus 240 pp. illus. English translation by H. Greene. London.

—*Journal of Forestry*, vol. 38, No. 10, dated October, 1940.

VOLUME LXVII 171 NUMBER 4

INDIAN FORESTER

APRIL, 1941

A NOTE ON SEMAL, BOMBAX MALABARICUM, D.C.

BY JAGDAMBA PRASAD, B.SC., LL.B., P.F.S.,

Experimental Assistant Silviculturist, F.R.I.

1. *Introductory.*—If recent enquiries relating to this species are an index of increasing interest, the present article should find a welcome from forest officers and the timber trade. The former are aware that the name of the species is *Gossampinus malabaricus* (DC) Alston, but until it becomes generally known, it seems proper to continue to call it *Bombax malabaricum.*

It is of interest to know that *semal* was introduced in sub-tropical South Africa about two decades ago and has done well (13).

2. *Uses.*—It is a suitable softwood for planks and boxwood, but is not of importance where strength is a governing factor.

Its weight at 12 per cent. moisture content is 25 lb. per cubic foot (14). In the classification for weight of woods, air-dry (12 to 15 per cent. moisture), it thus falls in the category of lightwoods (23 to 27 lb.) (15). In strength as a beam it is very weak. In the table of hardness it falls in the "extremely soft" class. Its probable average life is stated as 12 months, for untreated wood, half buried in the ground and half out in the test yard of the Forest Research Institute, Dehra Dun, where termites and fungi abound. Its calorific value is 4,885 calories (8,794 British Thermal Units). It is, however, exceptionally free from cup shakes (15).

Semal is used for box veneers and packing cases in the match industry. It is very good for boxes and, although the splints are not very good, it is largely used for them (15). It is commonly used for boxes and tea chests (4).

Tests carried out at the Forest Research Institute, Dehra Dun, indicated that the species is suitable for the manufacture of plywood for the making of containers where strength is not too important a factor. The tests were carried out on particular specimens, but no guarantee can be given that they were representative.

Logs for veneers must be as cylindrical as possible. The timber must not be spongy and brittle like cork. Logs ranging from four feet six inches to nine feet (barked) are most in demand (16). Three-ply is common in India, the size most in demand being five feet by four feet. *Semal* is one of the woods used by the three plywood factories in India, two of which are in Assam and the third at Kallai in South India (15).

Seasoning.—In the log the timber becomes discoloured and is attacked by insects, unless completely submerged. First-class results were obtained by green conversion, placing the planks in running water for six weeks and storing in open stacks. Boards so stacked for three years were used for boxes and were in excellent condition (14).

Wood wool, which is used as a packing material, consists of fine strips of wool shaved off larger pieces of wood by special machinery. The Woodworking Institute at Bareilly, U.P., manufactures a certain amount of wood wool, *semal* being one of the woods used for the purpose (15).

The floss obtained from pods known as silk cotton or *kapok* is superior to Java *kapok* in buoyancy and almost equal in withstanding rough treatment, which are qualities of importance in the manufacture of life-belts, etc. It satisfies the Board of Trade specification for buoyancy (18). Actual tests conducted by the Imperial Institute as well as by the Admiralty have shown that *semal* floss is in no way inferior to the true Java *kapok* (*Eriodendron anfractuosum*), though it is likely to be adulterated with the much less useful *akund* floss (*Calotropis* spp.) (15). No information is available of the yield of *kapok* per acre or per tree. Plants begin to yield *kapok* from the fifth year in certain localities.

The floss is collected before the fruits ripen, as when the fruit bursts it loses much of its resilience (26). It is used for stuffing mattresses and upholstery, for surgical dressings, for wadded clothes, quilts and as insulating material in refrigerators.

The oil of the seed and the oilseed cake are of superior quality and readily saleable (18).

Semal gum, known as *mocharus*, is a common Indian bazar medicine. It is an astringent and is used in diarrhœa, dysentery

and menorrhagia (18). It is also used mixed with ashes and castor oil as a cement for caulking iron sugar-boiling pans in Assam (26). The roots of younger plants particularly contain substances (phosphatide cephalin and mucilage) which act as a tonic (18). It is slightly inferior to the true gum-tragacanth. The gum usually flows naturally from wounds due to decay or insects; incisions in the healthy bark do not cause a flow of the gum (15).

The leaves and wood of *semal* contain no tannin and the twig or mature bark is not considered of value as a tanstuff (8).

The immature calyx (not yet fully open), is used as a vegetable and is known as *semargulla* in the U.P.

The tree is classed as a medium fodder species (30). The seed is valued as a nourishing food for cattle, which also greedily devour the flowers.

3. *Distribution, Locality and types of Forest.—Semal* forms one of the principal constituents of type 3/2-S-7(*b*)—North Indian Lower alluvial savannah forest (tropical moist deciduous forest: seral type) (28), but is not confined to that region. It is found throughout India and Burma, excepting the tract comprising Rajputana, Sind, Kathiawar, Baluchistan and the N. W. F. Province in India and the strip running north-south west of the Irrawaddy river in Burma, broadly speaking (14). It is also found in the Andamans (1).

Its distribution appears not so much governed by climatic as by edaphic factors. It is commonly found on deep alluvial ground, where it reaches its best development (11). Clayey and marshy soils are, however. unsuited for it (25). In Bengal it is found from the plains, where it prefers a light soil near big rivers, up to 3,000 feet.

On stony sandstone slopes around the Janala Tank in North Chanda Division, C.P., according to Mr. H. G. Champion, it forms up to 70 per cent. of the overwood locally, in open type of forest with bamboo.

Well-drained areas above the flood level are suitable for plantations. The species does well in a light soil with moisture (7). Water-logged portions of plantations in North Chanda and Bilaspur Divisions, C.P., were complete failures.

The estimated supply from the various provinces and states, according to the figures compiled in 1921, totalled 47,324 tons per

annum, the exploitable girth varying from 4 to 10 feet, with Assam at the head of the list, followed by Burma, C.P., Bombay, etc. (26).

The temperature limits in the natural habitat of *semal* are 95 to 120 degrees F. and 25 to 65 degrees F., the rainfall varying from 30 to 180 inches and over (11).

4. *Phenology.*—In some cases, particularly in dry situations, the leaves turn yellow and commence to fall in the beginning of December, the tree being leafless by the end of that month. Some trees, particularly in moist situations, may remain in full leaf till March. The new leaves appear in March or April. The showy scarlet flowers appear in January and February and sometimes continue to the end of March. Fruits ripen in April and May (11). While observations made during the last nine years at Dehra Dun generally confirm these dates of leaf-shedding, flowering and fruiting given in Troup's *Silviculture of Indian Trees,* a remarkable feature is the indication that the character of leaf-shedding in this species is perhaps to some extent a racial one. Thus, while local trees shed their leaves by the end of December, those of Burma origin do so in February and March. No definite conclusions can yet be drawn, however, as the observations have to be made for a few more years to determine the secular trend of the data.

Early flowering in December is not at all an uncommon phenomenon in Assam. The flowers are occasionally yellow or orange instead of the usual deep-red colour (20). Pollination of the flowers is effected by birds as well as by insects.

5. *Silvicultural Characters.*—A very large deciduous tree with straight, cylindrical stem and horizontally spreading branches in whorls; large trees are nearly always buttressed at the base (11). According to Mr. E. Marsden, *semal* sometimes produces two whorls in one year, as countings made in 1914 or 1915 indicated that at an age of 8 or 10 years there was sometimes one whorl too many. He never found more than one whorl in excess, but fancied it quite possible. The second whorl appeared to him to be thrown out late in the season.

Semal is an intense light demander, a character that precludes it from forming a pure dense crop. It is a species to be encouraged in the regeneration of the older riverain areas and grassy blanks.

6. *Mixture of Species.*—As Mr. Laurie pointed out at the 1939 Silvicultural Conference, "there is only one ultimate object of a mixture and that is to increase the sustained value output of the crop. Pure crops may fail to produce the highest sustained net-value output for any of the following reasons:

(*i*) Deterioration of soil conditions.

(*ii*) Epidemic attacks of insects, fungi or *Loranthus*.

(*iii*) Poorer growth form of pure crops.

(*iv*) Pure crops may be of lower value than a mixed one.

A mixture of *semal* and *khair* (*Acacia catechu*) falls in the last category. The *Bombax* may have to be wider spaced than normal for the *khair* to develop properly, and the *khair* may not be as good as when grown without any overhead cover, but the total returns from two acres of such a mixed plantation are likely to be greater than from a single acre of each."

In a 1915 teak plantation in Burma, *semal* grew well, being slightly taller (47 feet by 7½ inches diameter against 45 feet by 6 inches diameter) and apparently not definitely harming the teak.

7. *External Dangers.*—The insect, *Dysdercus cingulatus,* feeds on the seed juice, the seeds becoming useless for germination. The bud worm, *Tonica niviferana,* Wlk., attacks seedlings, destroying the young shoots and often killing the plant outright. The borer, *Glenea spilota,* is reported from plantations in *jhums* in Assam. *Semal* is frequently attacked by the Cerambycid beetle, *Plocederus obesus,* as well as by another large Cerambycid, *Monochamus soongna.* The pods are often badly damaged by the Noctuid moth, *Mudana cornifrons,* Moore. Tea boxwood at Calicut was found much damaged by a boring beetle, *Bostrychus aequalis,* Wat. (12).

Porcupines, rats and mice also gnaw the roots of young seedlings. Hares also cause damage. Bison and deer browse and trample young plants. Fencing is essential in animal-infested country.

Drought affects the species. The seedlings are fairly hardy to fires and grazing, but not to frost.

8. *Methods of management.*—The systems of management extant seek to exploit trees of marketable size on the

usual principle of equal annual yields, subject to modifications to suit local requirements. Thus in the Nagpur-Wardha Division, C.P., the felling cycle is 20 years and the exploitable girth three feet six inches (5), in the Tarai and Bhabar Estates, U.P., the cycle is 15 years and the exploitable diameter of trees over 28 inches (6), while in the Bhandara Division, C.P., the felling cycle is 20 years and the exploitable girth 4 feet (7).

9. *Natural Regeneration.*—*Semal* regenerates itself in open spaces where the soil is suitable (10). In Sambalpur, natural regeneration of *semal* is good and coppice reproduction fair (3).

The provision of floss, which is attached to the seed, is meant for seed dispersal by wind. A conclusion that can be drawn from this device of nature is that it did not intend the species to regenerate under the parent tree, and that it intended colonisation over wide areas.

From observations made in the Nowgong Division, Assam, it is found that advance growth of *semal* is scarce in areas grazed throughout the year, or not grazed at all, and prolific in areas grazed only during the cold weather by buffaloes. Breaking up of the soil by cattle probably assists regeneration, and fire protection brought about by grazing and the closing of the area to grazing during the growing season assists establishment (23). From Darrang Division of the same province it was reported that excellent results could be obtained if the undergrowth was well-burnt, while from Sadiya Division it was reported that regeneration could materially be helped by grazing over light jungle lands for at the most two years by buffaloes. It was also observed that *semal* reproduces itself well in the more open ground.

Semal produces root-suckers and this character may offer a cheap method for restocking the forests (21). In a 200-acre clear-felling area in the Tarai and Bhabar Forest Division, U.P., several hundred large trees of *Bombax malabaricum* over 28-inch diameter were felled. In the plantation area lines 15 ft. apart and 4 ins. deep were dug in April and May for sowings. Where the lines crossed roots of *semal* and where these were wounded and exposed in the digging of the lines, vigorous root-suckers resulted. The size of the original tree

did not seem to matter, as root-suckers resulted even from big trees and came up at places as far apart as 90 feet from the felled tree. This suggests an easy method of obtaining regeneration in fenced areas (22).

10. *Artificial Regeneration—Seed Collection.*—The usual time for collecting seed is mid-March to mid-May. The fruits are best collected off the tree, when they just begin to open. The pods are then put out under wire-netting in the sun, to open.

A convenient method of separating the seed from the floss is to place the floss with the seed attached in a large, open basket. A round stick about two feet long and one-third to half an inch in diameter is prepared and at two inches from one end of it two pointed cross-sticks about five inches long each are tied firmly to the long stick and at right angles to it and to each other. This end of the long stick is then put into the cotton and the stick is revolved rapidly in alternate directions by rubbing it between the palms of the hands; this causes the seeds to separate from the cotton and sink to the bottom (11).

Seed Weight, Germinative Capacity and Plant per cent.—The weight of the seed varies for different provinces. The details are given below (29):

Locality	Weight of seed (number to the ounce)	Germinative capacity	Plant per cent.
Forest Research Institute, Dehra Dun ..	820	38	31
Assam	1,500	..	..
Bengal	780	40	..
Burma	980	..	..
C. P.	..	100	100
Punjab	720	14	6
U. P.	680	50	..

Seed Supply.—Supplies can usually be arranged for by Provincial Silviculturists.

Seed Storage.—Seed can be stored, if necessary, in sealed tins. Fresh seed gives the best results, however. The results of tests carried out at Dehra Dun are as follows:

Date of collection	Date of first test	GERMINATIVE CAPACITY							
		Fresh	Stored in sealed tins, for (years) 1	2	3	4	5	Stored in gunny-bags for (years) 1	2
April, 1932 ..	May, 1932 ..	52	36	37	1	4	..	0·7	*Nil*
May, 1933 ..	August, 1933	39	18	4	12	1	*Nil*	9	*Nil*

Treatment of Seed.—No pre-treatment of the seed to accelerate germination is necessary.

Nursery Practice.—Seeds of *semal* were sown in nursery beds and watered daily in Coorg, when the greatest percentage of germination was obtained in the second month after sowing, after which, however, it is stated no germination may be expected.

In Assam, in order to produce fibrous roots in the nursery suitable for transplanting, the tuberous root of the seedlings was cut off; but this led to the production of another tuberous root. And when this was cut off, another appeared. It was thus found impossible to produce a compact fibrous root system.

Seeds are sown in the nursery three inches apart in drills nine inches apart in May, shaded from the afternoon sun, weeded and watered until the rains break. Plants are suitable for stumps when a year old.

Direct Sowing, Transplanting and Stumps.—Propagation from stumps 1½ inch shoot and 12 inches root has so far given the best results at Dehra Dun. A big stump appears best, probably of one-inch diameter. Poorer results are obtained with shorter root lengths, e.g., of 6 inches.

The details of *Experiment* 53.—*Comparison of direct sowings, transplants and stumps,* conducted at the Forest Research Institute, Dehra Dun, are of interest. Seed was collected on the 1st of May, 1936, for direct sowings and raising stock for transplants in the

nursery. Seed was sown in the nursery for the supply of stumps on the 13th June, 1935, and for transplants on the 20th June, 1936.

Direct sowings were done in prepared patches (the soil being worked to a depth of nine inches and one foot wide) with 12 seeds in each patch, on the 14th June, 1936. Germination commenced on the 18th June, 1936, and was completed by the 21st of August, 1936, when sowings were thinned to two of the best plants per patch. Entire plants were planted on the 10th July, 1936, and stumps ($1\frac{1}{2}$-inch shoot and 12-inch root) on the 15th June, 1936. The diameter of the stumps used ranged from 0.4 inch to 0.8 inch. The results (29th November, 1938), were as follows:

	Sowings	Transplants	Stumps
Average height ...	19.9 inches	17.5 inches	26.9 inches
Survival per cent. ...	75	28	85

Stumps were significantly superior to sowings and transplants. Most of the entire plants and plants of direct sowings were frosted to ground level. The stouter plants from stumps escaped frost damage.

Some success has been obtained with cuttings of root sections (6 inches or 9 inches long) and additional stocking can thus be obtained from the root sections cut off in preparing stumps which need not be thrown away and wasted.

Stumps are planted out a week before the break of the monsoon rains, in crow-bar holes, the soil being compacted at the time of planting by inserting the crow-bar slanting towards the plant and pulled away from it, so that the earth round the root gets firmly pressed.

At Rajabhatkhawa it was found that the seedlings left through one season's rain in the nursery could be transplanted when leafless in January and early February, after trimming the taproots. Transplanting at the beginning of the second season's rain was not successful, the growth being checked at the beginning of the growing season (10). The species transplants badly, however, and the method is not recommended.

For direct sowings the species is best sown on prepared mounds of loose mineral soil, spaced 12 feet by 12 feet, just at the beginning of the rains, using about six seeds per mound, and if spaced 24 feet

by 24 feet, with other species between. The mixture helps in minimising damage from the shoot-borer. Blanks can be filled up the following year with stumps.

Taungya.—Sowing with field crops is the best method of raising *Bombax malabaricum* (7).

The seeds are best sown at stake in *taungyas,* a spacing of 9 feet by 9 feet being close enough. The seed germinates in about four days and the plants grow very fast. In the Lakhimpur *taungya,* Assam, 18-month-old plants were from 8 feet to 15 feet high and trees in their third year up to 30 feet high.

Raising *semal* with rice cultivation (spacing 26 feet by 26 feet) was found promising in Assam. The best results are obtained by sowing *semal* a week before the rice. A useful measure was the grant of a reward of rupees four per thousand established plants to *taungya* cultivators on the abandonment of the *taungya.*

When the seedlings are established, all but the best seedling at each stake are pulled out and used to fill in vacancies elsewhere. Mr. J. N. Das (19) recommends a spacing of 22 feet by 22 feet, as it is easy to calculate the acreage for one thing. It has been observed, he continues, that a reasonable distance between trees of six feet girth should be 40 to 50 feet. In a plantation of 22 feet by 22 feet, the final distance would be 44 feet by 44 feet, giving 22 final trees per acre.

Cost of Plantations.—The 1929 Plantations in the C.P. cost Rs. 54 per acre, but only Rs. 26 per acre, excluding the cost of fencing. Sowings were done 10 feet apart in furrows that were ploughed up thrice before, in these plantations. It is indicated that if ploughing is necessary it had better be combined with the raising of agricultural crops to keep down costs.

11. *Tending.*—*Semal* is a fast grower and requires little tending after the first year. Rains weeding is, however, necessary and grasses must not be allowed to stifle the plants during the early stage.

Semal is a good species for afforesting new soil and for grasslands, provided it is kept well weeded for two years. Grass seems to affect its subsequent growth less than it does that of most species (9).

The tree should be given full growing space throughout its life and as soon as crowns are touching, alternate plants should be removed.

12. *Statistical Data.*—In 1929 timber in the round sold at Rs. 25 per ton of 50 cubic feet in Assam and sawn timber at Rs. 70 to Rs. 90 per ton in Calcutta.

In 1930-31 the royalty realised by the U.P. Forest Department amounted to two annas nine pies per cubic foot for timber sold to the Western India Match Company (24).

The prices of plywood chests (4 mm. thick and 19 inches by 19 inches by 24 inches in size) were Rs. 2-6-6, 3-4-5 and 5-5-1 each in 1933, 1939 and 1940, respectively.

In general, the wood sells at about twelve annas per cubic foot at Chanda, C.P., in the log and yields the Forest Department about four annas per cubic foot.

Rate of growth:—(27)

	Growth in diameter in inches (d.b.h. over bark)		
Age in years	Haldwani and Tarai and Bhabar	South Chanda	North Chanda
10	6.0	...	...
20	12.5	(5.6)	5.4
30	18.9	(8.5)	8.4
40	25.3	11.4	11.3
50	31.8	14.3	14.0
60	...	17.1	15.4
70	...	19.9	16.5
80	...	(22.6)	17.2
90	...	(25.4)	(18.1)
100	...	...	(18.8)

With care at the initial stage plantations can be established in three to five years and the mature crop obtained in 20 to 40 years in the moister regions for purposes of matchwood according as the growth is rapid or medium. Under favourable conditions trees of six feet in girth are produced in about 25 years and 25 to 40 trees of an average girth of four feet six inches per acre represent a fully stocked area for all practical purposes. For rate of growth and diameter growth curves a reference may be made to publications (27), below. No yield tables are available for the species. The table on page 182 gives a rough estimate of outturn.

ROUGH ESTIMATE OF OUTTURN OF *BOMBAX MALABARICUM* PLANTATION (GORAKHPUR, COORG, BURMA AND ASSAM)

Age (years)	Number of Stems per acre	Average Diameter in inches	Main Crop standing Volume	Thinnings No.	Thinnings Volume Periodic (cu. ft.)	Thinnings Volume Accumulated (cu. ft.)	Total Volume (Thinnings *plus* Final Yield)	Mean Annual Increment
0	200	..	..	..	..	..	..	..
10	75	15	900	125	625	625	1,525	152
20	40	22	1,600	35	1,050	1,675	3,275	163
30	30	27	2,250	10	550	2,275	4,475	150
40	25	31	2,500	5	375	2,600	5,100	127
50	22	35	2,920	3	300	2,900	5,820	116
60	20	38	3,400	2	260	3,160	6,560	110
70	20	41	4,200	..	..	3,160	7,260	104

BIBLIOGRAPHY

Working Plans

(1) Andamans Forest Division (1914-15). By F. H. Todd.

(2) Sambalpur East Division. By F. C. Osmaston.

(3) Sambalpur Division (1921-22 to 1940-41). By J. W. Nicholson.

(4) Chittagong Division, Bengal (1922-23).

(5) Nagpur-Wardha Division, C.P. By K. P. Sagreiya.

(6) Tarai and Bhabar Estates. By M. D. Chaturvedi.

(7) Bhandara Division, C.P. By Jagdamba Prasad.

General Notes

(8) Report of an Investigation of the Forest Concession of the Buxa Timber and Trading Co., Ltd., at Rajabhatkhawa, North Bengal. By J. A. Pilgrim (1920).

(9) Forest Pocket Book. By S. H. Howard (1937).

Plantation Notes

(10) Nursery and Plantation Notes for Bengal (1935). By C. K. Homfray.

Manuals

(11) Silviculture of Indian Trees (1921). By R. S. Troup.

(12) A Manual of Indian Timbers (1922). By J. S. Gamble.

(13) Exotic Forest Trees in the British Empire (1932). By R. S. Troup.

(14) Commercial Timbers of India (1932). By Pearson and Brown.

(15) Manual of Indian Forest Utilization. By H. Trotter (1940).

Indian Forester

(16) Manufacture of Matches in Rangoon. By A. J. Butterwick. *In. For.,* XLIV(9): 412—417 (1918).

(17) Indian Semal Cotton Plantations, Ltd., *In. For.* LX(8): 515-516 (1934).

(18) *Bombax malabaricum.* By T. P. Ghose. *In. For.,* LXVI (2): 93—103 (1935).

(19) A Short Note on Semal Plantations in Assam. By J. N. Das. *In. For.* LXII(5): (1936).

(20) Flowering of Semal (*Bombax malabaricum*). By R. N. De, with a Note by C. E. Parkinson, *In. For.* LXII (7): 1936.

(21) Root Suckers of Semal (*Bombax malabaricum*). By L. B. Holland. *In. For.* Dec., 1936.

(22) Root Suckers from Semal (*Bombax malabaricum*). By D. Stewart. *In. For.,* March, 1937 (page 188).

(23) Grazing and its Effect on Semal Regeneration. *In. For.,* Nov., 1937.

Research Reports

(24) U. P. Research Report on Utilization, 1930-31, page 6.

(25) Report on Forest Research Work, Bombay (1930-31).

Publications of the Forest Research Institute, Dehra Dun

(26) Note on Semal or Cotton Wood. By C. E. C. Cox. Forest Bulletin No. 44 (1921).

(27) Volume Tables and Diameter Growth Curve for *Bombax malabaricum.* By I. D. Mahendru. *I.F.R.* (IV), 1932 and XV(V), 1932.

(28) A Preliminary Survey of the Forest Types of India and Burma. By H. G. Champion. *I.F.R.* I (1): 1936.

(29) Seed Weights, Plant Percents, etc., for Forest Plants in India. By J. N. Sen Gupta. *I.F.R.* II (5): 1937.

(30) Fodder Trees in India, issued by the Silviculturist, F.R.I., Dehra Dun (1938).

THE EVERGREEN GHAT RAIN FOREST; AGUMBE-KILANDUR ZONE

[A STUDY IN THE TROPICAL RAIN FOREST OF THE WESTERN GHATS OF MYSORE]

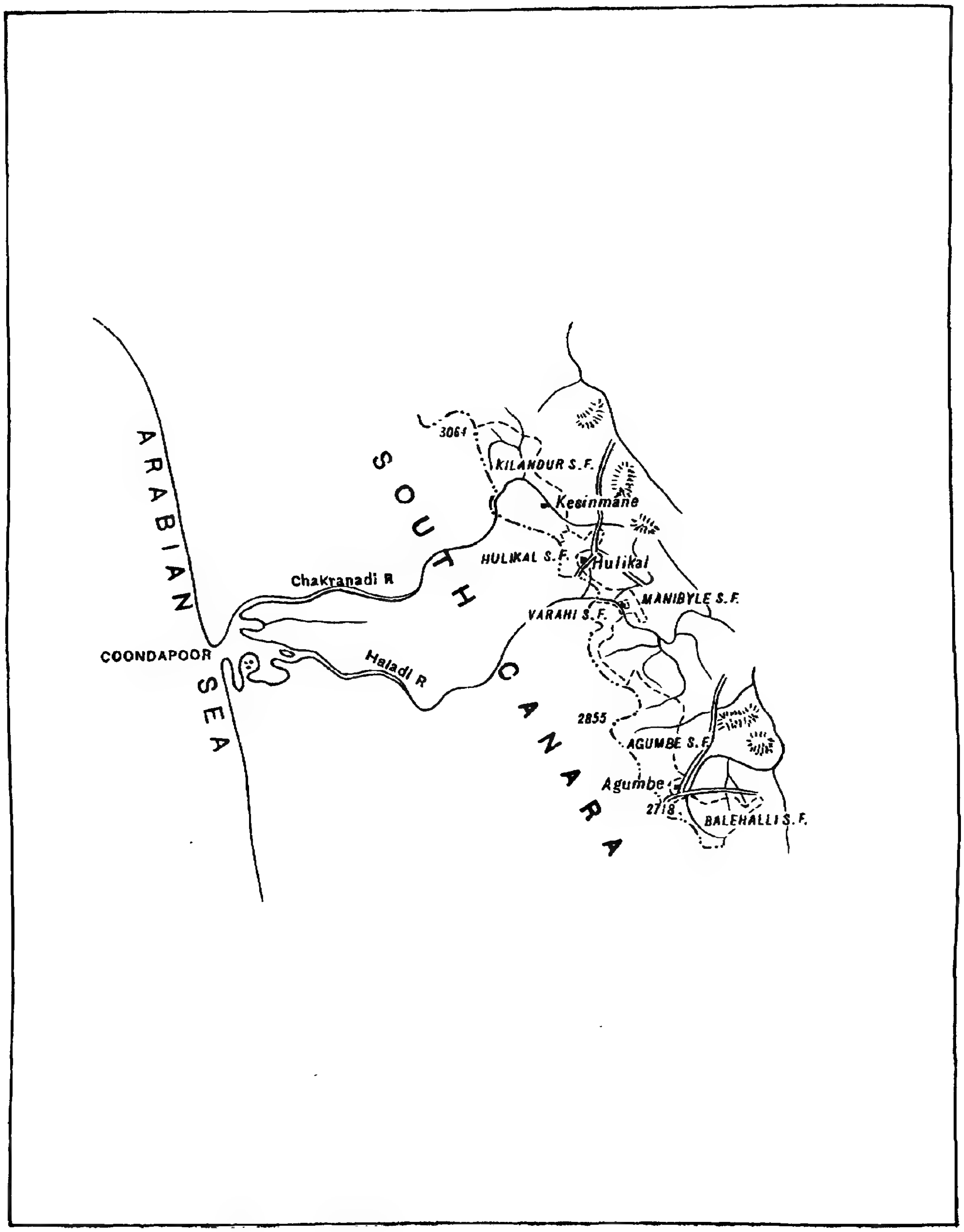
BY DR. KADAMBI KRISHNASWAMY

Situation.—The reserves in question occupy the major portion of the Ghat crest area of the Agumbe and Nagar Forest Ranges overlooking South Kanara and extend as a long, narrow belt, about 31 miles long and 2½ miles broad, within the Revenue District Shimoga, adjoining the western boundary of the State. They lie within 13°—27′—30″ and 13°—51′—45″ north latitude and 74°—57′—0″ and 13°—10′—0″ east longitude (vide map in Plate 6).

Configuration.—The general latitude varies between 1,060 and 2,500 feet. The country is often precipitous and embraces some of the most difficult type of hilly country in Mysore.

Geology, Rock and Soil.—The underlying rock is generally gneiss. Hornblende schist covers the northern portion and extends as a narrow belt about a mile broad all along the crest of the Ghat. The surface rock is often a bed of laterite found in discontinuous patches varying in thickness up to 20 feet. On hill-tops the soil is shallow, while in valleys it is deep and rich in humus content and consists of gravelly loam of lateritic or granitic composition. Local aspect and elevation influence the climate. The seaward slopes and the plateau have a fairly distinct climate, but the hills and valleys cause considerable local changes and with them varies the distribution of the important tree species. The temperature varies between 55° and 95° Fahrenheit.

Humidity.—The air is humid at all times, its percentage rarely going below 80 per cent. even during the driest part of the year and, during the rainy season, it does not swerve for days together from the saturation point. In February and March, when the humidity is generally the lowest, the early morning fall of temperature results in the release of a considerable quantity of moisture from the atmosphere which, deposited in the region of the tree crowns, comes down as a perceptibly heavy, continuous drip on the forest floor in the early part of the morning.


ARABIAN SEA
SOUTH CANARA
COONDAPOOR
Chakranadi R
Haladi R
3064
KILANDUR S.F.
Kesinmane
HULIKAL S.F.
Hulikal
MANIBYLE S.F.
VARAHI S.F.
2855
AGUMBE S.F.
Agumbe
2718
BALEHALLI S.F.

Rainfall.—The rainfall varies between 200 and 350 inches a year and the area under description contains some of the rainiest localities in the State, if not in the whole of Southern India. Agumbe, famous on account of its heavy rainfall, is often called the "Cherapunji of Mysore." The Ghat head region actually receives much more rain than what the rain guages generally record, because the latter are situated a mile or two in the interior of the plateaus, where rain is considerably less.

Forest Type.—H. G. Champion, in his classification of forest types, places these forests under the type, "Southern Tropical Wet Evergreen." He describes them as follows:

"Lofty, dense, evergreen forests, 150 feet or more high, characterised by the large number of species of trees which occur together. Consociations (gregarious dominants) are rarely met with and two-thirds or more of the upper canopy trees are of species individually contributing not more than 1 per cent. of the total number; a few species may be met with semi-gregariously but this is not typical. Some species of the top storey are trees with clear bobs 100 feet long and 15 feet or more in girth, and may be deciduous or semi-deciduous without affecting the evergreen nature of the forest as a whole. The canopy is extremely dense and it has been demonstrated that, apart from the scattered giants which project well above the general canopy, differentiation into definite canopy layers probably does not exist (Davis and Richards, p. 357). *Epiphytes* are numerous, especially aroids, ferns, mosses and orchids. Climbers vary greatly in amount, being sometimes conspicuous but often not so; on the whole, they are less characteristic than in the semi-evergreen and moist deciduous forests. Ground vegetation in typical cases may be almost absent; elsewhere a carpet of *Strobilanthes* or *Selaginella* and ferns may occur; grasses are absent. The undergrowth is often a tangle of canes, creeping bamboos and palms, which may replace high forest as cane brakes along streams. Erect bamboos are unusual, but may occur locally. Long cylindrical boles usually with thin smooth bark and typical plank buttresses are also frequently seen. The leaves are thick and glossy, only rarely finely pinnate or hairy, and are often white or pink when young. Cauliflory may be relatively common."

Schimper divides forest growth into four main types, determined by differences in the amount or incidence of rainfall:

Tropical rain-forest is the first of his divisions, which he describes as follows:

Evergreen, hygrophilous in character, at least 100 feet (30 meters) high, but usually much taller, rich in thick-stemmed lianas, and in woody as well as herbaceous epiphytes. The plank buttress is a peculiarity of trees in a tropical climate with abundant rainfall.

Chipp, in his aims and methods of the study of vegetation, places the type in question under "Rain Forest." This is, according to him, forest continuous at lower altitudes; temperature high and constant; dry season short, if any.

J. Burtt Davy, in his publication, *The Classification of Tropical Woody Vegetation Types,* suggests the name "Tropical Lowland Evergreen Rain-forest."

R. S. Troup, in his book, *Silviculture of Indian Trees,* calls this zone of forests "tropical evergreen or rain-forests." These are described by him as follows:

"The tropical evergreen or rain forests are characterised by the great luxuriance of their vegetation, which consists of several tiers, the highest containing lofty trees, often with buttressed bases, reaching a height of 150 feet. The intermediate tiers consist mainly of evergreen trees crowded together and struggling for light. There is a luxuriant growth of climbers, while the trees are covered by numerous epiphytes."

Although the above names are broadly applicable to the forests under consideration none of them indicate satisfactorily the nature of the forest growth in relation to the locality of its occurrence. I therefore propose to call them *"Evergreen Ghat Rain-forest."* The word "Ghat" has special significance because the forest exhibits certain local peculiarities which have resulted from the ecological conditions which reign at the crest of the Ghat.

In addition to moisture and warmth, both of which are abundant and have been recognised as necessary for the development of the climax type of growth in the tropics, the effect of wind has de-

cidedly influenced the local distribution of species, the condition of the forest and the size and shape of some of its component members. Altitude by itself has exercised no appreciable influence but it is the wind that seems to have decided the vertical distribution of the species and the variation of the shapes of some trees.

The evergreen forest, which covers the Bababudan, Kalhathagiri and Mulliangiri, all of which lie in the interior of the Mysore Plateau, are distinctly different in growth and composition from the evergreen forest at the head of the Ghat. This "tableland-shola" does not contain some of the more important species which lend their characteristic appearance to the forest of the Ghat crest shola, and among such trees are *Poeciloneuron indicum* and *Dipterocarpus indicus*. Whereas in the Ghat crest region from the forest floor to the region of the crowns of the tallest trees it is a mass of evergreen in which the differentiation of the so-called forest storeys is scarcely possible, in the tableland shola forest, a more or less distinct separation of the growth into forest tiers is possible. The altitudinal distribution of the growth is also different. (*Vide* Working Plan of the Forests of Bhadravati Division, Bababudangiri State Forest, the Evergreen Shola Type, by Dr. K. Krishnaswamy, 1936). Four distinct growth regions are distinguishable there:

(1) The region of the deciduous forest growth occupying the foot and the fore hills region and merging into the mixed, typically deciduous forest of the Mysore tableland, up to an altitude of about 2,000 feet.

(2) The zone of the dense evergreen shola forest from about 2,000 feet to about 3,800 feet.

(3) The zone of stunted tree growth between 3,800 and 5,000 feet.

(4) The region of the bare grassy hill-tops over 5,000 feet and more. (Compare next paragraph).

It is not the elevation or aspect that sets a limit to the tree growth here but the wind and the isolation. The growth consequently hugs the leeward sides of the tops of the hills and the tree limit is placed considerably higher on the leeward than on the windward slopes.

A.—ALTITUDENAL DISTRIBUTION OF FOREST GROWTH IN THE GHAT CREST SHOLA

Three regions are recognisable:

(1) The region of evergreen growth from the toe of the Ghat (500 feet) up to an altitude varying with the aspect from 800—1,000 feet;

(2) The Ghat crest region proper, from about 1,000 feet to about 2,500 feet; and

(3) The region of the sparsely-clad and bare hill-tops lying above the Ghat crest region. (*Vide Fig. I, Plate* 7.)

The altitudinal distribution of the types is here conspicuously different from the "Tableland Shola Type" although the rainfall and temperature are more or less the same in both localities or the former factor—rainfall—is actually more favourable for tree growth in Ghat head zone than in the tableland shola forest. For this difference the effect of wind is primarily responsible and to a smaller extent also the pronounced western aspect of these localities. The Western Ghats rise as a giant wall about 2,000 feet high facing the sea and standing across the main direction of the monsoon wind which blows with little abated vigour for about seven months in the year and the whipping effect of this wind which, perhaps, reaches in places a velocity of 250 miles or more at the crest of the Ghat, is very severe.

One has only to go up any open situation overlooking the sea during June and July to appreciate the effect of this wind. The force of the cloud-laden wind from the sea is suddenly impeded and made to rise vertically upward against the side of this high, natural wall and, on reaching the top of the same, the wind rushes inward over the crests of the hills and past the hill-tops through the gaps and high valleys at a terrific velocity. Though laden with rain-bearing clouds and surcharged with water vapour and floating minute particles of water in its free state, this wind is inimical to the development and expansion of tree crowns. They become, therefore, stunted and bushy, with leaves of diminished size placed on short, branchy boles, an appearance which is characteristic of the trees of this zone.

Fig. I

Photo : Author.

The region of the sparsely-clad or bare, grassy hill-tops lies above the Ghat Crest region.

Fig. II

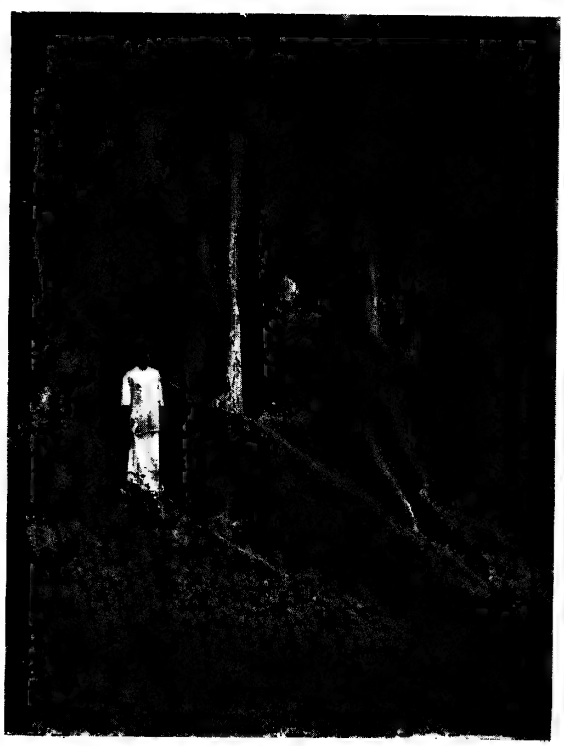


Photo : Author.

Elæocarpus tuberculatus, conspicuous on account of its buttress roots, is the chief tree in the "*Elæocarpus* type."

The aspect, over the major portion of the zone, is western. The desiccating effect of the afternoon sun at these elevations, especially during the dry season of the year, is considerable and adds to the adverse effect of the wind in these localities.

DESCRIPTIONS OF THE GROWTH REGIONS—VERTICAL AND HORIZONTAL

(1) *The Region of Evergreen Growth from the Toe of the Ghat to an Altitude of* 800 *or* 1,000 *feet locally.*—The forest contains an intimate and rich mixture of mostly evergreen species covering the lower half of the steep western slope of the Ghat. Floristically it is characterised by the absence of two of the most important evergreen species, *Poeciloneuron indicum* and *Dipterocarpus indicus*. The prominent trees found here are of the genera *Hopea, Artocarpus, Sterculia, Holigarna, Eugenia, Diospyros, Garcinia* and *Calophyllum,* and in the lower portions of this zone *Lagerstroemia, Grewia, Terminalia, Pterocarpus, Bombax,* etc., appear. Palms and Canes are abundant at the top and make way for the big bamboo further down.

(2) *The Ghat Crest Region from about* 1,000 *to about* 2,500 *feet.*—This contains the most luxuriant evergreen forest and one which contains the most valuable timbers of the evergreen zone in the state. It is the home of *Poeciloneuron indicum, Mesua ferrea, Dipterocarpus indicus, Hopea parviflora,* the White Cedar, the Ebony, the Red Cedar and a host of other species associated with the climax type of evergreen growth. The common associate tree species are the following:

Palaquium ellipticum, Aglaia odoratissima, Schleichera trijuga, Canarium strictum, Hopea wightiana, Dysoxylum malabaricum, Bischoffia javanica, Nephelium longanum, Calophyllum elatum, Machilus micranta, Gordonia obtusa, Lophetalum wightianum, three species of *Garcinia,* three species of *Myristica,* three of *Litsaea,* five of *Diospyros,* three of *Holigarna,* at least six species of *Eugenia,* seven of *Ficus,* two of *Elæocarpus,* one of *Euonynus* and two varieties of *Mangifera indica.*

Among the species in the underwood are.—*Lansium anamalayanum, Humboldtia brunonis, Polyalthia coffeoides, Unona pannosa, Chailletia gelonioides, Canthium Sp.* and three species of *Psychotria.*

(3) *The Region of the Sparsely-clad or Bare, Grassy Hill tops.*—Here the trees are generally stunted and low branchy, and the leaves are frequently smaller than what one finds for the same species within region No. 2: the genera *Olea, Wendlandia, Allophylus, Eugenia, Symplocos, Glochidion, Plectronia* and *Linociera* are represented here, and bushy strobilanthes fringes the stunted tree growth. The hill tops are grassy, with some bracken (*Pteris aquilina*) and *Phœnix humilis.*

B.—HORIZONTAL DISTRIBUTION OF THE TREE SPECIES

The evergreen forest, though looking to all outward appearances remarkably uniform in construction, is found, on closer examination, to exhibit much variation of detail. Proceeding from the Ghat-head inwards into the plateaux one finds that the composition of the growing stock varies rapidly with increasing distance. At least five, often very irregular, but more or less distinct belts of growth or associations of species are recognisable: they are:

(*a*) *The Poeciloneuron and Mesua Association: Underwood of Lansium.*—This is a very narrow, but more or less distinct though interrupted belt which occupies the wind-swept Ghat-head overlooking the Arabian Sea. The most conspicuous feature is the absence of *Dipterocarpus indicus* in the overwood and of *Humboldtia brunonis* in the underwood. The crowns of trees are generally meagrely or frequently unilaterally developed. Bark mosses are confined to the leeward side of the boles. The branches are often also rich in epiphytic moss and Usnea growth.

The underwood contains *Lansium, Memecylon* and some *Unona.* The udergrowth contains some *Psychotria* and *Chailletia.* Patches of *Pinanga dicksonii* are present in the undergrowth. The following genera are generally represented among the tree-forming species:

Myristica, Garcinia, Palaquium, Litsaea, Schleichera, Diospyros and *Eugenia.*

(*b*) *The Poeciloneuron—Dipterocarpus Association: Underwood of Humboldtia.*—Next to the above and extending irregularly over large areas, often two miles or more into the interior, is found this association of trees. *Dipterocarpus* avoids the windward crest of the Ghat but is one of the most conspicuous trees on the leeward

side, and often occurs in groups or small, irregular patches in a considerably pure state. The underwood of this zone is *Humboldtia brunonis* which, with its erect candles of sweet-scented pink blossoms often presents a striking appearance at the end of the wet season. Other members of the underwood are *Lansium*, *Memecylon* and *Unona*. The bushy undergrowth contains *Psychotria* and *Chailletia* as above. Patches of *Pinanga dicksonii* are present in the undergrowth.

(*c*) *The Poeciloneuron-Palaquium Association.*—Underwood-*Unona* and *Humboldtia.*—This covers nearly all the areas in between the patches of growth occupied by association "b" except the banks of streams and similar low lying localities. *Dipterocarpus indicus* is rare, or found as isolated trees. The principal woods are *Poeciloneuron indicum* and *Palaquium ellipticum.*

(*d*) *The Hopea Association.*—*Hopea wightiana* is the chief species and is found along with a sprinkle of *Hopea parviflora. Poeciloneuron indicum*, *Dipterocarpus indicus*, *Palaquium ellipticum* and *Mesua ferrea* are absent. The associate species are: *Artocarpus integrifolia, A. hirsuta, Olea dioeca, Mimusops elengi, Symplocos spicata, Holigarna arnottinna, H. grahmii, Canarium strictum, Glochidion lanceolarium, Myristica malabarica* and others.

This type is generally found beyond a three-mile zone from the Ghat head and represents, probably, a transition stage to the true evergreen climax.

(*e*) *The Lagerstroemia Association.*—This represents the pre-climax stage of the evergreen forest and is found in all localities where the evergreen forest is gradually closing in upon the blanks, a large number of which are found in the evergreen zone, covering often extensive areas. It is also found where the evergreen forest, once destroyed by man, is again in the process of formation.

The forest is low, open and consists of a good number of deciduous species. *Lagerstroemia lanceolata* is the chief among them; among its associates are *Careya arborea, Dillenia indica, Buchanania latifolia, Randia uliginosa, R. dumetorum, Zizyphus rugosa, Mallotus philippinensis, Plectronia didyma, Olea dioica* and *occasional*, very stunted trees of *Terminalia tomentosa, T. belerica, T. chebula, Semecarpus anacardium, Butea frondosa, Dalbergia latifolia, Bombax malabaricum* and *Alstonia scholaris.* The ground is covered

by grass, bracken (*Pteris aquilina*), *Phoenix humilis* and *Wendlandia notoniana*. At the edge the evergreen high forests, the shrub *Ligustrum nilgherrense* forms often a dense fringe. This type is very common in the northern portion of Kilandur forest and to a less extent in the Agumbe and the Balehalli.

The correct ecological status of this type seems doubtful. When the type is found on the tops of hills and ridges, where high forest never seems to have existed before but the vegetation has remained in a state of permanent stagnation owing to the combined effect of local annual grass fires and unfavourable soil conditions resulting from the presence of laterite rock too near the surface, wind, etc., this type has to be looked upon as a local edaphic climax. In places where, owing to destruction of the evergreen forest by man, the cycle of the vegetation leading to the climax type restarts and the above association of species is a stage in the repair of the evergreen forest to its original state, the *Lagerstroemia* association represents probably a pre-climax condition which will sooner or later pass on to the evergreen climax, if not interfered with by man. Here again, if there is human interference and annual fires become a common feature, this state of stagnation may last indefinitely long. The following quotation from the author's description of this locality (*Quarterly Journal of the Mysore Forest Department*, July, August and September, 1934, page 29) makes this point clearer:

> "The blanks can, according to the probable cause of their origin, be placed under two categories: (1) Those for which man is solely responsible, which may be either abandoned cultivation sites, or spots from which the rural population extracted fuel and leaf manure in the past, and (2) Those caused either by unfavourable conditions of soil or drainage or both, for example spots where laterite stone is found at the surface of the soil or waterlogged areas."

(*f*) *Elæocarpus Type*.—This is an edaphic variant in localities where associations (*a*) and (*c*) above are found. *Elæocarpus tuberculatus* vide Fig. II, Plate 7 is the principal species and is found, at times, almost pure. Its natural regeneration is generally abundant. Its associate species are generally *Gordonia obtusa, Ficus nervosa,*

Hydnocarpus wightiana and *Lophopetalum wightianum*. There is sometimes a tangle of canes and lianas. *Pandanus* is common in the undergrowth.

(*g*) *Lophopetalum Type*.—This type is also an edaphic variant on the *Hopea* association (*d*) and is confined to the borders of streams. The associate species contain *Elæocarpus tuberculatus, Gordonia obtusa, Euonymus tingens, Ficus nervosa, Hydnocarpus wightiana, Carallia lucida* and others. A tangle of canes and lianas is sometimes present. *Pandanus* is common in the undergrowth.

Pen Picture of the Forests.— When the forest is seen from outside, say from an opposite elevated point, many differences between it and a deciduous forest strike the eye. (The Evergreen Forest, Agumbe Area, by the author; *Quarterly Journal of the Mysore Forest Department*, July, August and September, 1934, page 23.) The upper surface forms a varied mosaic, in which every shade of green is present, the most frequent of these being the dark-green. By the mere tint of the foliage an experienced person can recognise many of the valuable trees in the forest and often get a better picture of the relative abundance of the important woods than while walking through the crop on the forest floor. The side-view of the evergreen forest differs considerably from those of the deciduous ones. Overwhelmed with lianas and epiphytes, especially on the banks of watercourses, the stems are sometimes scantily visible. In a sectional view of the forest such as we have along the demarcation lines the great diversity in the size of the tree trunks, the variety in the form of the tree crowns and the irregular tangle of lianas are conspicuous. This lends to the forest its characteristic look of maximum disorderliness.

In the interior of the forest also the picture varies from place to place. Sometimes one passes through immense, dark-pillared halls where there is a free passage and fairly clear outlook in all directions and only a few ferns, tuberous plants or seedlings of the tree species on the ground and a few epiphytic orchids, ferns or mosses provide a green tint. Approaching the borders of the perennial streams or a valley overlooking the crest of the Ghat the forest often displays a dense mass of foliage from the ground to the tops of the trees, through which one can make one's way only with some difficulty or occasion-

ally be totally stopped by the impenetrable tangle of thorny canes and lianas or by a heavy growth of *Pandanus*. These two extremes are connected by every stage of intermediate form, where more or less abundant underwood appears.

It is difficult to obtain a clear view of the systematic composition of the vegetation. As for the large trees, only felling them might facilitate our object, but occasionally even this may not be easy as the trees are bound together by tangles of lianas. Groups of trees are often found enveloped by *Entada scandens* in the northern position of Kilandur State Forest where these are called "Ganape-thali" by the villagers (vide Fig. I, Plate 8). Even felling the trees may not always lead to decisive results, for many trees bloom but rarely and that for a short period in the year. A few families can, of course, be recognised by their characteristic fruits, such as the *Myrtaceae* and *Meliaceae* by their berries, the *Myristicaceae* by their seeds and the *Dipterocarpaceae* by their winged fruits.

Sometimes only the corollas are found on the ground, but there is always a possibility of these flowers and fruits falling from the large number of lianas which lead one to an erroneous conclusion. Most of these lianas hide even their foliage from the view of a man standing on the forest floor, and any attempt to pull them down ends, as a rule, in disappointment.

The trees possess, in many cases, characteristic barks; in *Myrtaceae* the bark peels off in flakes; in certain *Leguminosæ* the bark is greenish; in certain *Guttiferae* the bark has characteristic furrows and tinges. In the genus *Myristica* a blood-red exudation rapidly emerges and trickles down the bark on wounding it. *Mesua* has a bark peeling off in flakes and exuding a whitish liquid turning yellow; the *Guttiferae*, in general, exude a deep yellow, resinous liquid from their bark on wounding; in the genus *Holigarna* a dull white corrosive juice oozes out of the chopped bark, which turns black on exposure. After some experience one can correctly recognise several genera and species by merely observing the peculiarities that can be examined from the surface of the ground, such as the colour and thickness of the bark, the exudations from the tree surface on being chopped with a sickle, the conspicuous plank buttresses or stilt roots—the outstanding examples of the last two being the

Fig. I

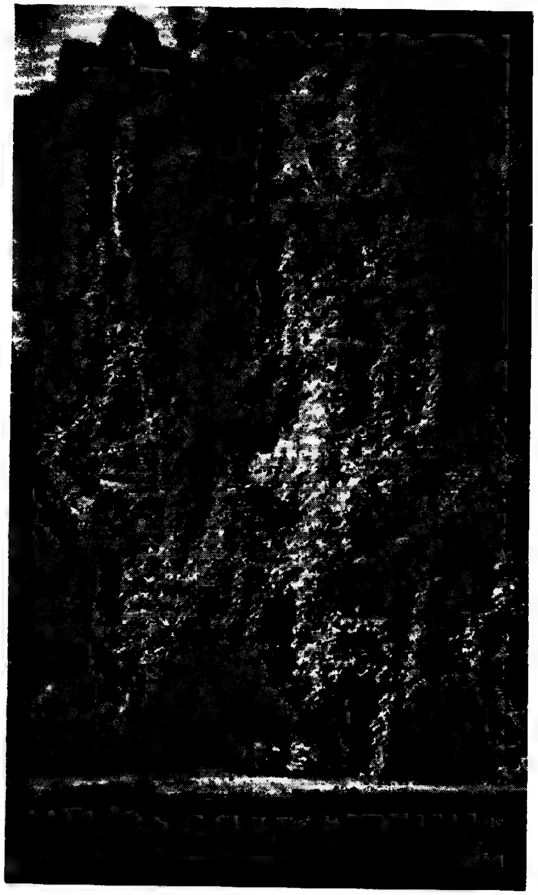


Photo : Author.

Groups of trees are often enveloped by *Entada scandens*, locally called "Ganape-thali."

Fig. II

Photo : Author.

A crown photograph of *Dipterocarpus indicus* taken from the ground, showing how this, the tallest tree of the evergreen forest, unfurls its full foliage to the sun.

genera *Elaeocarpus* and *Poeciloneuron*—and rarely, from the branching of the trees and the tinge of the young foliage.

It is easier to acquire a knowledge of the systematic composition of the underwood, because many of these flower and fruit for a longer time in the year than the trees do.

The ferns, in general, can be identified during the months of November, December and January, when they bear their spores. Tree ferns are rare and, if found, are confined to the banks of streams, the solitary genus at Agumbe being *Alsophila*. Most of the undergrowth is, however, composed of *Dicotyledons*. A fine show is made in the flowering season by the *Melastomaceae*—*Memecylon edule, M. amplexicaule, Melastoma malabathricum*, the *Rubiaceae-Pavetta* sp., *Psychotria* sp. and the climber *Mussaenda,* the last of which has one of the sepals in its flower developed into a dazzling white leaf which contrasts against the orange yellow corolla. During the rainy season one comes across very many shrubs and small trees without either flower or fruit. In the darker parts of the forest the herbaceous vegetation is poor but in the better lighted portions, or portions which have been exposed by the felling of some giant tree, it is often surprisingly luxuriant. The *Scitaminae*—especially its sub-family *Zingiberaceae*—such as species of *Zingiber, Elettaria* (wild Cardemom) *Costus* and *Alpinia* are preponderant; the gregarious *Strobilanthes* alone may form the herbaceous vegetation over large areas, and occupy the ground with its tall, juicy, brittle stems standing far above a man's height. The wild cardemon may often occupy the ground all by itself in any ready opening of the canopy occasioned by the fall of some mighty tree owing to old age, wind or by man. The *Aroidae* may also be frequently seen on the ground, while the saprophytic *Burmanniaceae* are very rare.

The Storeyed Vegetation.—The evergreen forest has been described by some as being composed of distinct storeys but a pronounced distinction into tiers is not really possible. There are, in fact, as many tiers as there are individuals, the whole forming a confusing array of closely packed trees. In localities where the *Poeciloneuron-Dipterocarpus* association is found, however, two storeys are more or less clearly seen, *Dipterocarpus indicus* occupying the upper and *Poeciloneuron* and the rest of the forest the lower.

Based, however, on the capacity for maximum height growth in these localities the trees could be artificially separated into at least four tiers of growth. (The Montane Evergreen Forest, Bisale Region, by the author—*Indian Forester,* 1939, page 195.) The top storey contains trees which generally raise their crowns well over the rest of the forest and unfurl their full foliage to the sun (vide Fig. II Plate 8). Though numerically the trees of this layer form a small percentage of the growing stock, yet they contribute most to give the vegetation its stately look and form. Most of these reach, when full grown, heights of 150 feet and girths of 14 feet and over. Among them are *Dipterocarpus indicus* (Dhuma), *Calophyllum elatum* (Surahonne) and occasionally *Mangifera indica* (Mavu) and *Elaeocarpus tuberalatus.* The next storey is composed of tall trees which from the bulk of the top canopy. Among them are: *Poeciloneuron indicum* (Balagi), *Mesua ferrea* (nagasampige), *Dichopsis elliticum* (syn: palaquium (hadasale), *Mastixia arborea* (gulle), *Machilus michranta* (gulumavu), *Holigarna arnottiana* (Holegara), *Eugenia sp.* (chikkani), *Canarium strictum* (kaidhupa), *Aglaia odoratissima* (kempunola), *Diospyros sp.* (Doddele-Karimarlu), *Elaeocarpus tuberculatus* (sataga), *Litsea wightiana* (sudagenasu), *Ficus sp.* (Kanathi), *Hopea parviflora* (kiralbhogi), *Garcinia sp.* (kanjiraka) and *Dysoxylum malabaricum* (devadari). The third storey is composed of moderately large trees which, though not so tall as the foregoing set, yet fill up the bulk of the space underneath the top canopy. Among them are *Schleichera trijuga* (kendala), *Myristica magnifica* (ramanadike), *M. malabarica* (rampathre), *M. attenuata* (sannele-ramagotu), *Litsea sp.* (doddele-sudagenasu), *Garcinia indica* (guragi), *G. Cambogia* (kadagolmuruga), *Cinnamomum iners* (kankutla), *Lophopetalum wightianum* (Bilehebhalasu), *Hopea wightiana* (Haiga), *Chrysophyllum roxburghii* (hale), *Ficus infectoria* (kare-basali), *Ficus tsiela* (bile-basali), *Ostodes zeylanica* (bale), *Eugenia jambolana* (nerle), *Eugenia sp.* (Malenerlu), *Sterculia guttata* (Hulitordu), *Holigarna grahmii* (Holegara), *Elaeocarpus serratus* (Kyasatte), *Gordonia obtusa* (Mallanga) *Holigarna sp.* (Badacharlu), *Nephelium longanum* (sannele-kendala), *Alstonia scholaris* (Maddhale), *Diospyros ebenum* (Kari-bale), *Amoora canarana* (Hottenala), *Cedrela toona* (Gandhagarige), *Symplocos spicata* (chunga), *Litsea*

stocksli and *Litsea sp.* (Kaggundi). The palm *Caryota urens* also belongs probably here. The fourth tier consists of a limited number of trees all relatively small (about 30 feet high) and some often found almost in a pure state or intimately mixed up with a relatively small number of other species. These trees form the underwood of the evergreen forest.

Among them are: *Lansium anamalayanum* (Chigatumari), *Humboldtia brunonis* (Asagi or Kanasoka), *Unona pannosa* (Kadubende), *Memecylon edule* (Hulichappu), *M. amplexicule* (vollekodi), *Polyalthia coffeoides*, *Chailletia gelonioides* (Kadutengu) and *Eugenia laeta* (Kadupannerle). The palm *Pinanga dicksonii*, belongs to this tier.

Among the erect shrubs, which constitute the fifth tier of vegetation are *Psychotria dalzelli P. truncata, Ixora coccinea Pavetta indica, Gardenia sp.*, the stinging nettle—*Laportea crenulata*, and *Memecylon sp.*

The herbaceous plants are scanty in the denser portions of the forest where practically no light reaches the soil and a few ferns here and there are all that could be seen. Where some light reaches the soil appear, however, a multitude of herbaceous plants among which are the *wild plantain, wild turmeric, wild ginger, wild cardamom, wild arrowroot, Alpinia galanga, Clerodendron infortunatum*, species of *Peperomia, Amorphophallus*, and others. Among the erect palms are found, apart from *Caryota urens* and *Pinanga dicksonii*, already mentioned, *Arenga wightii* (dadasalu) which is very common in some places, especially in the Kilandur forest where it is present in the rich valleys adjoining perennial running water. There are no less than five kinds of climbing palms—canes—known locally as Handibetta, Jaddubetta, Halubetta, Nirubetta and Sannabetta of which the third often forms difficult cane brakes along the watercourses.

Climbers are not, on the whole, so very conspicuous within the evergreen forest itself where the canopy is complete, but where the forest is not of the densest and the canopy consequently admits some light, as also along the banks of the perennial streams where the canopy is naturally interrupted owing to the presence of water, climbers are often extraordinarily abundant and the stems of trees are overladen with lianas and rendered scarcely visible. Abundance

of climbers sometimes indicate, except near running water, a regression from growth of the best quality to one less good. There are a host of climbers whose systematic position is in many cases doubtful and whose collection and identification is attended with considerable practical difficulty. Some of them are very pretty and bear handsome flowers, while others are heavy and harmful.

The ferns appear in large numbers and make a fine show, especially on road cuttings, banks and along watercourses.

A host of liverworts and mosses appear especially during the rains; among them are the genera *Riccia, Marchantia, Anthoceros, Fossombronia, Bryum, Polytrichum* and such others. The bark algae *Chroolepus* and *Scytonema* are pretty common and numerous fungi develop their sporophores after the rains, the most conspicuous among them belonging to the families *Agaricaecae* and the *Polyporaceae,* while the prettiest are the *Dictiophoras* or stink horns, which develop their short-lived pink or white nets at the end of the rains.

The above picture represents the condition of the forest in its virgin state but this condition has changed in many places as a result of forest exploitation. Poles and sleepers have been extracted in considerable quantities, leaving often lasting breaks in the canopy behind, and the oecological balance has consequently been locally upset either temporarily or permanently. Stages of regression from the climax type are noticeable in these localities and three such stages following the exploitation are recognisable. They are:

Sub-sere (1)—This is found in places where a lasting break in the canopy has been caused, but the gap is small and there is no consequent deterioration of the forest soil; the wild cardamom and other wild herbaceous plants have occupied the ground, amidst which the natural regeneration of the evergreen tree species like *Hopea parviflora, Mesua ferea, Poeciloneuron indicum, Dipterocarpus indicus,* etc., have settled down.

Sub-sere (2)—Where there is a lasting break and a large one so that the marginal shelter of the evergreen forest is inadequate, the humus disintegrates rapidly and the mineral soil gets exposed; occasionally a local fire might burn the débris, if any, of the fellings and convert all the organic material to ash. Here, fast-growing,

light-demanding and short-lived species like *Leea sambuicina Callicarpa lanata, Macaranga roxburghii, Colebrookia oppositifolia* and *Trema orientalis* have settled down and covered the soil. The natural regeneration of evergreen tree species has also come up in the shade of these first settlers and is gradually making its way up to overtop and kill the above species later on.

Sub-sere (3)—Where a large opening has been caused owing to the destruction of forest from a landslip or a local fire and conditions for growth remain unfavourable for some years, the evergreen growth is replaced by a crop of deciduous trees of the genera *Randia, Zizyphus, Careya, Terminalia, Butea, Lagerstroemia,* etc., while the soil will be overrun by a sea of grass, Bracken and *Phoenix humilis.* The ecological balance is more or less permanently upset locally, and the forest suffers a severe setback to the deciduous state. This may last for a shorter or longer time according to circumstances. Sub-sere (3) represents the highest degree of regression caused by the destruction of the evergreen forest. The forest returns to its original state only gradually and in this process trees of *Glochidion malabaricum, Olea dioica, Symplocos spicata, Actinodaphne hookerii, Plectronia didyma, Allophylus cobbe,* etc., settle down in the opening and the shrub *Ligustrum nilgherrense* creeps in along the edges, while colonies of *Wendlandia notoniana* invade the area.

ECOLOGICAL FACTORS

The ecological factors which impress one on entering the evergreen forest are: the struggle for light, the competition for space and the abundance of moisture. To this must be added a fourth, namely, the abundance of dead and rapidly decomposing plant residue in the soil. The struggle for light is the most pronounced, as all available space is occupied by the green parts of plants, and hardly a ray of sunlight reaches the forest floor in the denser portions of the forest. The competition for space results from the great abundance of species and individuals, and for this the specially favourable growth conditions of the evergreen zone are responsible. The space available above the ground is considerable, as the topmost layer of the canopy stands over a hundred feet high from the ground. Moisture is more abundant in the evergreen type than in other types because the rainfall is often superabundant and the humidity of the

moisture-laden wind from the Arabian Sea is very high. Unlike the deciduous forest, however, it is not the rainy season that marks the period of great vegetative activity, but it is the period just after and that just before the heavy rains. An unbroken cover of heavy clouds bring down almost incessant showers during the rainy season and prevent even glimpses of the sun for about three months in the year, and conditions are then scarcely favourable for vegetative activity. During the rains, therefore, there is cessation of growth. The trees start putting forth their young leaves from the latter part of September onwards, when the onslaught of the monsoon rain has slowed down. The principal growing season is after the rains and till the commencement of the main period of reproduction during the driest part of the year. With the end of the flowering commences a second, but shorter, period of vegetative activity in the year, and this activity reaches a maximum soon after the premonsoon showers, to come to a still stand with the outburst of the south-west monsoon. During this period a good number of herbs and shrubs flower, though practically all the important tree species will be then in fruit.

The deciduous tree species, a couple of which are found in the evergreen zone, also behave more or less similarly. The species of *Holigarna* and *Sterculia* shed soon after the onset of the dry season in January and the flowers appear when the tree is practically leafless. The new leaves start after the flowers have dropped and the fruit is in formation, and the trees are in full leaf when the rains start. New shoots are put out again from September to November, when the tree once more prepares for the ensuing dry weather shedding.

The evergreen forest is thus marked by a more or less continuous vegetative and reproductive activity whose break, and that not a very sharp one, takes place during the period of maximum rainfall. The chief growing and flowering seasons correspond to the comparatively drier and driest part of the year respectively. (1) Owing, however, to the great multiplicity of the species and individual and the equability of the climate, the period of growth, flowering and fruiting is prolonged over a series of months, unlike in the temper-

(1) See *Indian Forester*, April, 1939, page 192.

ate zone when the spring ushers in a period of sudden and feverish activity. (2)

Even the statement so often made that in the evergreen forest there is no visible shedding season is only partly correct. The relatively heaviest leaf fall in the year coincides with the driest part of the year, and the thinnest clothing of foliage is found upon the trees at that time. In contrast to the deciduous forest, however, the trees are never leafless, because the soil moisture is adequate to enable them to continue their normal photosynthetic activity. The layer of dead leaves on the forest floor is relatively the densest at this time.

NOTES ON LEAF-FALL, FLOWERING AND FRUITING OF IMPORTANT TIMBER SPECIES

Species	Leaf-fall	Flowering	Fruit or seed maturity
Poeciloneuron indicum ..	..	January ..	June
Dichopsis ellipticum ..	March ..	January ..	June
Dipterocarpus indicus ..	March ..	January-February ..	May
Vateria indica ..	March ..	March ..	June
Artocarpus hirsutus ..	December	January-February ..	May-June
Artocarpus integrifolia ..	December	December-January ..	May-June
Calophyllum elatum ..	..	February-March ..	May-June
Mesua ferrea ..	..	March ..	June-July
Gordonia obtusa ..	..	February ..	June
Hopea parviflora, *H. wightiana*, *H. glabra* ..	..	February ..	May
Dysoxylum malabaricum ..	..	..	July
Diospyros assimilis ..	..	..	May-June
Diospyros microphylla ..	..	January-February ..	May-June
D. spp.	..	..	June
D. ebenum	..	March ..	June
Garcinia indica, *G. morella*, *G. cambogia* ..	..	March-April ..	July
Myristica magnifica, *M. malabarica*, *M. attenuata*, *M. laurifolia* ..	..	March ..	June-July
Actinodaphne hookerii ..	..	April ..	July
Scleropyrum wallichianum ..	..	March-April ..	July
Cedrela toona ..	..	January ..	April-May
Holigarna arnottiana, *H. grahmii* ..	December	January ..	April-May
Sapium insigne ..	December	February ..	April-May

(2) See *Indian Forester*, September, 1932, page 474.

The abundant organic matter that returns to the soil in the evergreen forest disintegrates with astonishing rapidity and the forest soil also depends to a large extent upon this disintegrating matter for its fertility. As soon as the forest is removed, the soil deteriorates rapidly and grass often appears. The rich humus rapidly disappears and as the overhead forest is no longer there to replenish the material removed, the soil gets quickly impoverished. In other words, the evergreen forest is largely responsible for creating and maintaining its own fertile soil, and the soil therefore also disappears with the removal of the forest. This accounts for the rapid change and regression of the climax type to a deciduous one on human interference and the gradual centripetal invasion of the evergreen growth on the forest blanks through a series of sub-seral stages.

NATURAL REGENERATION

This, of the more important species, is generally abundant wherever the conditions are favourable. The regeneration is less prominent in localities which have not been exploited for, although the trees in the virgin forest produce abundant seed—if only periodically—the requisite conditions for the establishment of the germinated seed are not very favourable. Practically no light reaches the forest floor and the young seedling is unable to reach the mineral soil with its root system owing to the dense layer of decaying vegetable matter covering it, and to nourish the growing plumule. The seedling, soon after emerging from the germinating seed, first attempts to secure a good foothold by thrusting a strong root system into the soil before developing its shoot,* and on its failure to do so properly it fails to survive. Mineral soil and some light are both necessary for the establishment of the seedling, and a judiciously worked evergreen forest is therefore better regenerated naturally than

* Strangely enough, in this respect the seedlings of species thriving under xerophytic conditions behave more or less similarly. There, the radicel first attempts to reach the deeper soil layers in search of water while here the seedling tries to establish connection with the mineral soil which is the source of its nourishment. The plumule remains undeveloped in both cases until this contact is established, i.e., the source of food supply is ensured. Ecological conditions very different from each other have yet produced precisely similar results in these two instances.

one in its virgin state. In other words, it is *necessary to exploit an evergreen forest to obtain adequate natural regeneration.* It is not the difficulty in obtaining adequate regeneration, but its securing and subsequent retention that sets a problem for the forest man in these forests.

The natural regeneration is, therefore, astonishingly abundant in all the sleeper-exploited areas—barring the over-exploited ones—less abundant in the localities where poles only have been felled in the past and least so in the unexploited virgin forest. In the last two localities, the seedlings and saplings are often found stagnating under the dense evergreen cover for want of light and every break in the cover or every extra ray of light admitted on the forest floor aids their development. The seedlings are, however, able to persist in shade for an indefinitely long time and to profit by the influx of light even after a long period of suppression.

EXTRACTS

THE MANUFACTURE OF PARCHMENT WRAPPINGS

Mr. F. D. JUDD, an assistant of the Titaghur Paper Mills, has at the Editor's request sent the following contribution. It is a very welcome article on a specialised branch of paper production of which the average printer knows very little.

Mr. Judd is amongst the several assistants of the Titaghur Mills who have joined the fighting forces and we are therefore all the more grateful to him for this paper written in his spare time whilst on field service.

Original parchments probably date back to three or four thousand years B.C. when they were made from the cured skins of animals, dressed and rendered fit for writing purposes. To-day, the term "parchment" is allowed considerable latitude, and is applied, often erroneously, to numerous grades of paper, for both writing and wrapping. Of the wrapping parchments in vogue at the present day, the product designated "pure vegetable parchment" is held in highest esteem, and resembles in many respects genuine sheep-skin parchment. Other wrapping papers, usually referred to as parchments, include greaseproof, glassine and waxed papers.

Before considering the manufacture and characteristics of these papers individually, it is advisable as a preliminary to examine the furnish of the latter qualities, and it will be found that greaseproof, glassines (or glazed transparents), and many of the body papers intended for waxing are all made from sulphite cellulose. Having a common basis, the procedure for the preparation of the pulp in each case is practically identical until the material arrives at the beating stage, when the ultimate character of the paper is formed.

Sulphite Wood Pulp.—Coniferous timbers, principally, are selected for the production of sulphite cellulose, and the nature of the resulting fibre is chiefly influenced by the use of bisulphites of alkaline earth metals, as calcium and magnesium, as the digesting agent. The customary course for the preparation of the boiling liquor consists of the burning of pyrites, or flowers of sulphur to produce sulphurous acid gas. After cooling, the gas is conducted to a

store of limestone. Water is allowed to filter through the lime, and in contact with the gas forms sulphurous acid, which in turn re-acts on the lime-stone to yield the required acid liquor, the greater proportion consisting of calcium bisulphite.

The chipped wood and necessary liquor having been charged into the digester, the boiling of the wood is effected under varying steam pressure, and for a duration dependent upon the peculiarities desirable in the pulp. In practice, the procedure differs, ten hours or more being allowed for digestion in the majority of mills. Specialised methods, extending the cooking period and reducing the steam pressure are known to achieve results above the average, although such operations are expensive and are not universally adopted. The boiling period completed, the pulp is thoroughly washed, strained and bleached in the normal manner, ready for beating. It is an acknowledged fact that the treatment the pulp receives in the beater decides to a pronounced degree the character of the finished paper. As sulphite pulp constitutes a fibre adaptable to the making of numerous qualities, it will be appreciated that the beating process should be manipulated to procure a pulp suitable for the purpose intended. Grease-proof and transparents are grades inviting special attention, but papers of sulphite furnish undergoing normal beating procedure are usually of a harsh nature, reasonably strong and durable, but lacking opacity. The latter trait is of little account in papers for general wrapping purposes but of considerable assistance in the making of transparents.

As a rule, in the region of 55 per cent. cellulose is obtainable from wood, and of this proportion, the sulphite method recovers approximately 80% which represents a comparatively high yield.

Greaseproof.—Normally, the "half-stuff" as charged into the beater has received a washing and bleaching operation, but still remains only partly disintegrated, and in a clotted condition. The beating process aims at the thorough separation of the individual fibres, the maximum consistency in the mixture and circulation of the pulp, and the precise degree of mutilation of the fibres, according to the quality under manufacture. With these objects in view it is necessary that adjustments be made to enable the beating engine to exercise either a sharp cutting action or a steady teasing effect upon

the fibres. It will be obvious that the sharp cutting action is quite unsuitable for preparing sulphite pulp for the manufacture of parchment-like qualities, since the fibres would be short and the ultimate sheet consequently lacking in strength and cohesion. To secure the desired grease resisting properties it is essential that the roll and bed-plate knives of the beater should be set accurately to tease the fibres apart, obviating any cutting or bruising action as much as possible. Although in ordinary circumstances, steel or phosphor-bronze tackle is fitted in a beating engine, for utmost efficiency, mills engaged on the production of greaseproof utilise stone and basalt lava equipment. During the prolonged beating operation a significant change also occurs in the formation of the fibres themselves, this being due to the natural process of hydration. The hydrating of cellulose causes the individual fibre to accumulate a transparent, aqueous deposit or coating, rendering the pulp smooth and glutinous, adequately fitted for the production of a cohesive sheet.

In passing to the papermaking machine, pulp of this gravity demands considerable suction to dispose of the surplus water before arriving at the couch rolls, and therefore, the running speed of the machine is somewhat retarded in comparison with the speed obtainable when running "free" stuff. Ultimately the product exhibits a strong close formation, inclined to transparency, but with the ability to resist the passage of greasy substances.

A genuine greaseproof can be determined by the application of oil of turpentine. When testing it is advisable to rest the sheet under inspection on a piece of blotting paper. If the applied oil penetrates, a stain will be observed on the blotting and, if this occurs, the sample under test will be lacking the required feature.

Many imitation greaseproofs are available in the market, but these cannot always be relied upon to fulfil requirements. Some of the cheaper imitations contain a percentage of mechanical wood pulp, and although this is usually visible to the trained eye, suspicion of its presence may be confirmed by the application of phloroglucinol solution, which will immediately produce a red stain if M. W. P. is present. The solution is obtainable from any good chemist and is prepared by dissolving 2 grammes of phloroglucinol in 5 c.c.s. of concentrated hydrochloric acid. After standing 25 c.c.s. absolute alcohol is added.

Glassine.—As applicable in many instances in the paper trade while the raw material and fundamental principle of manufacture is not substantially effected, slight modifications in the process can be made according to the precise nature of the quality specified. Glazed transparent is a case in point. A procedure similar to that followed for ordinary greaseproof is adopted, a higher degree of transparency being aimed at.

Glassine, glazed transparent, or transparent parchment (as it is variously termed) is customarily prepared from a strong sulphite pulp. Stone equipment is similarly employed for the beating operation which varies from four to six hours duration. Very little loading and only a small quantity of resin and alum size is added to the pulp in the beaters, and to ensure the flexibility of the finished sheet glycerine or sugar is also applied at this stage. Before emerging from the papermaking machine, the paper is passed through the calender rolls to supply a preliminary finish, and is then damped and conveyed to specially constructed calenders, usually comprising of twenty or more bowls. In the final operation, immense pressure is brought to bear on the paper, and the exceedingly accurate control of the friction applied governs the precise degree of finish and transparency desired. The exceptionally high measure of gloss imparted to this quality is, to a large extent, responsible for the clear even "look through" obtained.

Waxed Paper.—The body papers employed in the manufacture of waxed coated qualties vary from thin tissues and transparents to bulky parchments and packings, and many are of sulphite furnish.

The treatment through which the paper passes consists merely of impregnating the basis sheet with pure paraffin wax. From a general viewpoint there are two grades, and these are commonly referred to as "Self Sealing" and "Dry Waxing." For producing the "self sealing" type the body-paper chosen would be, preferably, a fairly well sized sheet with a good finish, these features being of considerable assistance in controlling the amount of wax absorbed by the paper. To counteract excessive oil penetration, titanium oxide is now employed as a filler when manufacturing papers specially for waxing purposes. Further this loading material is most useful to remedy the loss of opacity which usually occurs with papers under-

going wax coating. The machinery employed in coating "self sealing" papers also provides for the rapid cooling of the wax, immediately after the coating has been effected by rollers chilled by refrigerated brine. The result of this treatment retains the majority of the wax on the surface of the paper. With "self sealing" waxed papers practically any package can be hermetically sealed by the application of heat to the edges of the paper, as the surface wax melts and unites, and speedily cooling, forms a perfectly airtight joint.

The body papers selected for the "Dry Waxing" qualities are, normally, of low finish in order that the wax may penetrate into the paper. Such grades, of necessity, call for an external sealing agent for packing purposes.

Waxed papers are particularly suited for the packing of certain commodities and are supplied coated with wax, the melting point of which varies between 120° and 145° F. The finished product exhibits all the required features for a perfectly airtight and moisture-proof packing, the wax being odourless and tasteless.

A reliable method whereby to recognise a waxed paper is to burn a sample. It will be noticed that the wave of melting wax precedes the flame and sets white when the light is extinguished.

Pure Vegetable Parchment.—The making of pure vegetable parchment is a specialised process necessitating in the first place the production of the body paper and subsequently its chemical treatment. It will be observed that this differs materially from the method of making such qualities as greaseproof in which case the ultimate character of the paper is entirely dependent upon the treatment the pulp receives during manufacture. The basic paper chosen for transformation into a vegetable parchment is usually in the nature of a water leaf or unsized high grade bond of rag furnish, The chemical treatment to which the paper is subjected consists of immersing the material in sulphuric acid. The effect of the acid serves to break down the fibrous structure of the paper, partially dissolving the fibres to form a surface film. Following the recovery of the excess acid, the residue remaining in the paper is neutralised with ammonia and the product completed by a slow circuit over drying cylinders.

Vegetable parchment is impervious to the passage of air, moisture or grease; it is entirely neutral, and will retain its structure when immersed in water, which often occurs, for instance, with butter wrappers. Buyers having difficulty in distinguishing between a bleached greaseproof and a vegetable parchment may do so quite simply by masticating a small sample of each separately. It will be found that while the formation of a vegetable parchment remains intact, an ordinary greaseproof will revert to a pulpy state.—*Indian Print and Paper*, Vol. 6, No. 2, dated December, 1940.

FOREST WEALTH

W.A. POLICY PRAISED

MR. C. E. LANE-POOLE'S SURVEY

To facilitate the preparation of plans for forestry development in the post-war reconstruction period the Commonwealth Inspector-General of Forests (Mr. C. E. Lane-Poole) is visiting all States to discuss with Forest Departments the basis for concerted plans. He left Perth for the Eastern States yesterday by the Westland express after a short visit. While in the State Mr. Lane-Poole visited the forest areas with the Conservator of Forests (Mr. S. L. Kessell) and before he left yesterday he paid a special tribute to the splendid work done by the Forests Department. Praise from Mr. Lane-Poole is more than a polite gesture since he knows our forest country intimately—he was Conservator of Forests in this State until 1922 when he was commissioned by the Commonwealth to report on the forests of Papua and New Guinea. He was appointed to his present post in 1927.

"It was a great pleasure to visit Western Australia again and see the effect of sound management and patient silviculture on the forests," said Mr. Lane-Poole. "Twenty years ago the forests were burnt over as often as they would burn and the people really believed that this was the best treatment that could be given them. They contended that, by this means alone, could a big conflagration be avoided, and they held that, if the fires were kept out, the undergrowth and inflammable material would accumulate to such an extent that you wouldn't be able to hear a dingo howl, and, when the

fire came, the whole forest would be wiped out. In my journeys with the Conservator of Forests through the jarrah and karri belts, I have seen areas from which fires have been excluded for 12 and 15 years, and it is impossible to tell from the debris of leaves and twigs the difference between them and areas where the fire protection is only four years old. Forest equilibrium has been established, and the debris is disappearing by the agency of the insects and the fungi, and the fire risk is diminishing instead of increasing in that there is a layer of disintegrated detritus forming below last year's leaf-fall, and, as time goes on, the forest will again have its layer of humus.

FIRE PROTECTION

"For the first time I have seen the colour of the bark of a jarrah tree down to the ground. In my day, there was not a tree that had not a black-charred butt. I must congratulate the forestry service on the work it has done in protecting the forests from fire. I found the outlook of the people of the South-West towards fire very much changed, and there seems every hope that, year by year, they will lend a greater measure of co-operation to Mr. Kessell and his staff in this essential service. Until the whole population in the forest region is fire conscious the forests will not be safe. Apart from co-operation from the farmers and settlers, the department has still much to do in the way of subdivisional work to reduce the risk of large losses, and here is where Western Australia has so great an advantage over Victoria and, indeed, all other States. Roads, tracks and breaks can be made at a lower cost than anywhere else and are cheaper to maintain. Even so the bill is not a light one, for the forest estate is large and the revenue is limited.

"I was impressed by the organisation of the fire detection system. The triangulation of solid fire towers, some rising to 145 feet above the ground, and the subsidiary telephone services to selected settlers, all linked with the divisional headquarters, form a perfect observational organisation. The fire trucks equipped with all the fire-fighting appliances ready to start for any fire located by the tower men, show that no detail has been overlooked. . . . .

PROMISE OF BETTER RETURN

"Turning from protection to silviculture, I was most interested in the improvement that has taken place in the young stands of

jarrah and the splendid crop of seedlings and saplings that has followed the treatment of the karri forests. The young forests growing up promise to give a better return in volume per acre than the original forest, for crooked stems are being eliminated and protection has resulted in vigorous crowns. I found that I had to revise my estimate of the rate of growth of a jarrah tree, which had been made when the forests were burnt every four years or so. Now, from the figures shown me, Western Australia can expect growth in diameter as rapid as hardwoods on the east coast of Australia, or on the mountains of Victoria. This increase of average rate of increment, due to concentration on the vigorous trees and the exclusion of fire, is very gratifying, for there is so much leeway to make up when one considers that forestry is barely twenty years old in the State and sawmilling, prior to that, had what might be called an open go.

"As a safeguard against the possible exhaustion of supplies before the young crop is ready for the axe, the department's policy of reserving a proportion of vigorous trees even though they are of mill size is a very sound precaution. Here, on the management side, I was very struck by the change of outlook of the sawmillers. They now all seem to realise that a forest is not a mine to be exploited and abandoned, but a continuous source of timber, if only it is cut at the rate it is growing. The vigorous trees now looked at with longing by the fallers will, with the larger, though at present immature, younger trees, provide the mills with the logs they will require as the years roll on. So the aim of the forester is achieved—a sustained yield and the jarrah forest is cut over but never cut out.

"The silvicultural treatment and the protection are bringing the forest back to the conditions that some of the early cattlemen will remember. They used to describe to me how they could ride through the forests and see their stock many chains away. The destruction of the crowns of the big trees by fire resulted in the growth of large numbers of seedlings; these, in turn, were burnt back and sprouted several suckers, and these were multiplied by subsequent fires till the bush 'thickened up.' To-day the forester is unthickening it, and the crowns of the big trees are slowly regaining their vigour and soon we shall be able to see our forests in all their beauty.

MERIT OF MALLET

"I had the pleasure of seeing a most interesting example of artificially created forest near Narrogin. Brown mallet bark had been heavily exploited before the last war, and only isolated small patches of regrowth remained. The Forests Department set to work, some twelve years ago, to re-establish it by sowing, and the result is a spectacular success. Altogether 13,000 acres of new forest have been created and, in time to come, a sustained yield of the valuable tannin and also of a particularly tough timber will be obtained. It was not generally known till tests were carried out that the timber of the tree, the bark of which was so popular in Germany 30 years ago as a tanning agent, was the nearest substitute for hickory that Australia possesses. I doubted the figures at first, but, when I tested the wood for skis, I realised that here at last we had a handle, coach and general sports goods wood which was very close to hickory in its elasticity and toughness, and for skis it has the advantage of being harder.

"Another artificially created forest which should supply a serious want in Western Australia is the pine plantation north of Perth. Here the tree chosen is the Cluster Pine, which turned the barren waste sands of Gascony into a productive area of great value to France. The Forests Department encountered serious trouble in the establishment of this pine on the poor sands of Gnangara, but patient research appears to have overcome the infantile disorders which caused stagnation in the young trees. If the treatment continues successfully, as the department has every reason to hope, there is a very large area of land that can be afforested with pines. The fact that the plantation is within 15 miles of the metropolis makes it exceedingly valuable.

"I am carrying back to the East with me the feeling that Western Australia, under the hands of Mr. Kessell and his team of skilled foresters, is rebuilding its magnificent hardwood heritage in sound fashion. There can be no two opinions as to the reproductive nature of such an enterprise as this."—*The West Australian*, December 13, 1940.

INDIAN FORESTER

MAY, 1941

THE EARLY HISTORY OF INDIAN FORESTS

BY E. C. MOBBS

Extensive Forests at the Dawn of Indian History.—There is no doubt that in prehistoric times, and even within the earlier stages of historic times, India was very largely covered with more or less dense forests, populated by aboriginal tribes. The evidence for this is twofold. In the first place, there are extant various historical references to the former great forest wealth of India. Secondly, a detailed study of the distribution of the existing forests forces us to the conclusion that these are often but remnants of former much more extensive forests—for instance, the isolated patches of forest in the Gorakhpur District and the groups of old over-mature *sal* trees in present scrub land or savannah in various districts of the United Provinces must be the remnants of former more extensive *sal* forests.

The growth of modern India, with its innumerable races, is the result of successive waves of invasion or immigration from the north-west, and these have had considerable influence on the forests.

The Aryan invaders probably entered India some 2,000 years B.C. So far as we know, they were a pastoral and agricultural race, and to carry on their pursuits they must have been responsible for the burning and clearing away of considerable areas of the primeval forest wherever they settled. Records occur in fact in the ancient epics *Máhabhárata* and *Rámáyana,* and although much of these epics is perhaps legendary, much also has a basis in fact and can be regarded as records of the times.

In the *Máhabhárata,* allusion is made to a great forest tract, situated between the Ganges and the Jumna rivers, known as the *Khandáva* forest. The destruction of this forest by fire furnishes the first semi-historical evidence of the methods employed to get rid of the extensive jungles in order to extend agricultural and grazing lands. Great difficulty, it is said, was experienced in burning this forest, owing to the frequent rains which India poured down to

quench the fires. This forest is said to have been dark and gloomy and dense, stretching up to and along the banks of the Jumna, where there are now extensive dry and barren wastes.

Repeated burning, unchecked hacking and excessive grazing near the settlements, however, caused the ultimate disappearance of much of these forests. Gradually, stream flow and general moisture conditions must have been affected, and the general welfare of the people made more dependent on the vagaries of the climate. This had already occurred in some places, for reference is made in the *Máhabhárata* to drought and famine that devasted the regions where the earlier settlers had cleared the forest.

In the *Rámáyana,* which dates from the time that the Aryan empire was established in Oudh, there are many allusions to severe droughts in the more densely populated areas, and *Sringa, the Forest-born* is worshipped as the bringer of rains. Great forests are still referred to, however, very dense and stretching dark as a cloud in the wilderness of *Táraka.*

The exact situation and extent of this wilderness of *Táraka* is not clear. Some claim that it was in the Buxa District, but it has also been suggested that the reference may be to the forests of the Vindhyan and Satpura Hills. If so, the forest must already have been destroyed in the plains, and the forest boundary forced back to the hilly regions in those early times.

The Bráhman and Buddhist Periods.—During these periods there must still have been extensive forests, but much must have already been destroyed, with the result that the value of what still existed was becoming recognised—probably both for timber and fuel and for sport.

Gautama Buddha was born the son of a prince of a rich and populous kingdom, somewhere in what is now the north-west corner of the Gorakhpur District. He spent his time partly in populous places and partly in lonely forest. That the population was considerable and the civilisation advanced is shown by the discovery of many relics of Buddhist times and of the remains of very large monasteries, for instance at Kasia.

The Bráhamánas (probably 800 to 500 B.C.) refer to the *Govikartri,* or "Master of Forests," as one of the twelve important

officers of state, to whom the King or Raja was bound to make handsome offerings on the occasion of his accession or coronation. This officer was probably identical with the "great official" described two or three centuries later by the Greek writer *Megasthenes* as being in charge of "the huntsmen who cleared the land of wild beasts and of fowls which devoured the seeds." So this ancient Inspector-General of Forests was perhaps charged more with the protection of the people and the crops from wild animals than with the care of the forests. One wonders what the handsome offerings were that this officer received from his monarch! Perhaps they were jewels and clothes, or perhaps elephants, a herd of cattle, and a bevy of female attendants!

The Time of Alexander the Great.—The dawn of authentic history gives us further information and sidelights upon forest matters. Alexander the Great invaded India in about 327 B.C., and the records of the invasion made by his historian Arrian give perhaps the earliest authentic information. The north of the Punjab was said to be covered with dense forest at that time. Arrian says of the tract east of the Jhelum, an area now mostly very dry and treeless, and in part nothing but barren ravine land, that the forests extended there over an almost boundless tract of country, "shrouding it with shady trees of stateliest growth and extraordinary height." The climate was said to be "salubrious, as the dense shade mitigated the virulence of the heat, and copious springs supplied the land with abundance of water."

The Mauryan Empire.—The first great empire in India started with Chandragupta Maurya, who ruled over the greater part of India from 322 to 298 B.C. He started life as a young prince ruling one of the many small kingdoms to the south-east of Gorakhpur. His marriage to the princess of a kingdom to the north-west of the district threw the balance of power to such an extent in his favour that he embarked on a career of conquest. Soon he had an army of 600,000 men, with which he proceeded to build up his great empire.

Chandragupta's Brahman minister, Kautilya, compiled in about 300 B.C. the *Arthasastra*, a work on the Art of Government. This remarkable treatise on statecraft has only recently been known, having been discovered and published for the first time in 1905 by the Curator of the Mysore Government Oriental Library.

The *Arthasastra* contained several clauses relating to forests and their management. There were five classes of forests:

(1) *Forests set apart for the use of Brahmans,* in which they might study religion and cultivate the *sonia* plant, from which liquor was distilled for use in Hindu ritual, and in which they might perform their various penances. These forests were to be rendered free from all danger, animate and inanimate, by the Government. One wonders whether the inanimate dangers referred to ghosts and evil spirits and such-like, and if so what methods the Government adopted against them. Incidentally, the records show that these forests were not always used as was intended, for occasionally the presence of women at the hermitages was responsible for deplorable lapses from asceticism on the part of some of the Brahman recluses.

(2) Reserved Forests for the supply of all kinds of forest produce, particularly fuel and timber, houses in those days being all of timber. One or two such forests were to be maintained in every kingdom. They were also to provide a refuge in time of national calamity.

(3) *Elephant Forests,* where elephants, required for the state armies, might be allowed to breed. Owing to the demand for elephants for war, an elephant forest was much more valuable than a timber forest. Stringent regulations were made for the protection of the elephants, and death was ordinarily the penalty for any one who killed an elephant.

(4) *Sporting Forests for the Royal Use.*—These must have involved a great deal of maintenance, including planting work. They were surrounded on all sides by a moat and had only one entrance. They were planted up with all kinds of fruit and flower bearing trees and shrubs, and thorny trees and shrubs were definitely barred. They were further stocked with "tigers and other beasts of prey, elephants and bison, *all deprived of their claws and teeth.*" When sporting in these

forests, royalty in those days was surrounded by a bodyguard of armed women, purchased from foreign countries! Possibly the risks they took at home, and the difficulties of avoiding plots and assassins, made the royalty of those days wish to take no more risks than necessary in their hunting interludes!

(5) *Sporting Forests for the General Public.*—These were probably the remaining forests, farther away from the populous areas, and there was no special protection for the public, who hunted with bows and arrows.

The supervision of all these forests was in the hands of a "Superintendent of Forests," who had a large staff of forest guards. It was his duty to maintain the forests in good condition and to be acquainted with their roads and paths. He was also responsible for the punishment of offenders against the forest rules and regulations, and for the collection of timber and other forest produce, and arranging the supply of articles required in daily life and for the defence of the forts.

The punishments for forest offences, in terms of modern currency, were decidedly heavy. For trespass in a reserved forest the fine was from Rs. 150 to Rs. 350. For the illicit killing, trapping or molesting of protected animals or birds the fine might range from Rs. 350 to Rs. 1,400. For killing an elephant the punishment was death, and similarly also for damaging fruit trees, flowering trees or shade-giving trees in public places. For setting fire to a forest, the same penalty was given as to those who set fire to a building—"He shall be thrown alive into the same fire." Not only were punishments very severe, but to obtain a confession there were 18 kinds of torture, of which seven were varieties of whipping.

The list of produce for which the Superintendent of Forests was responsible is interesting. It includes:

1. Trees. These were subdivided into: (*a*) strong timber, (*b*) bamboos, (*c*) creepers, and so on, down to (*h*) medicinal roots and fruits, and (*i*) poisonous roots and fruits.
2. Skins of wild beasts.
3. Bones, bile, teeth, horns, hoofs and tails of wild cattle, birds and snakes,

4. Metals—iron, copper, lead and tin.
5. Utensils made of cane-bark and clay.
6. Charcoal and ashes.
7. Menageries and aviaries.
8. Firewood and fodder.

An interesting description is given of the Royal Hunt by Megasthenes, who was the Greek ambassador from the Syrian monarch, Seleneus I, to the court of Chandragupta Maurya. He says:

"Crowds of women surround him, and outside this circle are spearmen. The road is marked off with ropes, and it is death, for man and woman alike, to pass within the ropes. Men with drums and gongs head the procession.

The King hunts in the enclosures and shoots arrows from a platform. At his side stand two or three armed women. If he hunts in open country, he shoots from the back of an elephant.

Of the women, some are in chariots, some on horses, and some even on elephants, and they are equipped with weapons of every kind, as if they were going on a campaign."

The zenith of the Mauryan Empire was reached with Asoka Maurya, the grandson of Chandragupta. Under him the population increased and became very dense and highly civilised. His capital was at Pataliputra, the modern Patna, and his kingdom was divided into five great provinces. Four Viceroys ruled over four provinces, corresponding approximately with the present areas of Punjab, Bombay, Central Provinces and Orissa, and Bengal, while Asoka himself governed the fifth province, forming the "home countries," and covering Bihar, the United Provinces and part of Nepal.

It is probable, therefore, that in Asoka's time the forests may have become somewhat more restricted in extent, owing to the spread of villages and cultivation, and that it was the last class, the *Sporting Forests for the General Public* that suffered most.

After the Mauryan Empire.—Following the disruption of the Mauryan Empire, civilisation tended to move westwards, the centre moving first from Patna to Ajodhiya, and coming to rest eventually at Delhi. Many petty states were formed and there were long

periods of anarchy separating short periods of settled rule. Consequently, many areas, particularly in the east, became depopulated and reverted to jungle.

Heven Tsaing, the Chinese traveller, describing a journey in 635 A.D., from Kasia, the capital of Kapilavastu, some 25 miles north of Fyzabad, to Benares, tells of wild and deserted jungles, where towns were decayed and inhabitants few, and travellers went in danger of robbers and wild animals. He says:

> "From this place (Kasia, the capital of Kapilavastu) going East 300 li, across a wild and deserted jungle, we arrive at the Kingdom of Lanmo. The Kingdom of Lanmo has been waste and desolate for many years. The towns are decayed and the inhabitants few.
>
> From this Lanmo, going north-east along a dangerous and difficult road, where wild oxen and herds of elephants and robbers and hunters cause incessant trouble to travellers, we come to the Kingdom of Kushinagara.
>
> From Kushinagara, going 500 li through the great forest, we come to the Kingdom of P'o-lo-ni-ssee (Benares)."

The Mohammedan Invasion.—Considerable destruction of the forests again took place when the Mohammedans invaded India. This was in part caused by the Mohammedans themselves who, having no regard for the forests, nor any religious scruples about destroying them, cut them down for military strategic reasons, as they had already done in Asia Minor, Palestine and other countries. But it was partly also caused by the indigenous population, who fled before the ever increasing stream of invaders into the forests and the hills and mountains, where they frequently took to shifting cultivation,—a pernicious system, which is probably as destructive to forests as any other acts of man.

It is probable that the *Tharus* of the *tarai* forests of the United Provinces originated at this time. It is said that the Hindu princesses fled to the jungles with their servants while their husbands went forth to meet the Mohammedan invaders. The princesses, waiting in vain for their husbands, ultimately married their servants but made it clear that they were still the mistresses, so that jungle tribes have arisen among whom matriarchy is still practised.

The Mogul Empire.—The Mogul Emperors were notable for their horticulture, and planted trees for flowers, for fruit and for shade. Gardens were created, as for instance the Shalimar and Nishat gardens in Kashmir, and trees were planted in avenues along the sides of highways and canals.

Akbar directed "that on both sides of the canal down to Hissar, trees of every description, both for shade and blossom, be planted, so as to make it like the canal under the tree in Paradise; and that the sweet flavour of the rare fruits may reach the mouth of everyone, and that from those luxuries a voice may go forth to travellers, calling them to rest in the cities, where their every want will be supplied."

But although the Moguls had this passion for horticulture, they mostly cared little for the forests, although some were maintained for hunting. Shahjahan, for instance, built a shooting box in the forests of the Saharanpur Siwaliks, the remains of which are still visible at Badshahibagh to-day. Shaikhupura, formerly known as Jahangirabad, some 26 miles west of Lahore, was likewise formerly the hunting seat of Jahangir and of Dara Shikoh, the eldest brother of Aurangzeb.

While then gardens and avenues flourished under the Moguls, the forests were not specially looked after and were regarded as of value principally for the chase. At the same time, with the peaceful conditions, cultivation extended, and in some cases, if the statistics in the *Ain-i-Akbari* are to be relied on, there were areas where the land under tillage was even greater than the normal to-day. This is borne out by the remains of old habitations. In the Saharanpur District, for instance, the remains of old buildings, gardens, tanks, wells and tombs afford material evidence of former habitations in areas now covered with jungle, while from the names given to different portions of the forest, it may safely be conjectured that the woodlands were largely resorted to for pastoral purposes.

After the Mogul Empire.—With the gradual disruption of the Mogul Empire, and the frequency of political disturbances, many areas again fell into the impoverished condition from which they had been rescued during the prolonged period of peace. As an

example may be quoted the Gorakhpur District. In 1764 Shuja-ud-Dowla, the then Nawab Wazir, appointed a certain Major Hannay to command his troops and to collect his revenue in Gorakhpur. This officer is reputed to have combined oriental methods with his own thoroughness to such effect that large tracts were deserted and relapsed to jungle, and the district was probably more desolate then than at any other time in its history.

Forest growth, therefore, was again on the increase, although much must have been very poor scrub jungle of little value. having developed on abandoned cultivation or old grazing lands.

The Early British Rule.—With the advent of British rule in 1804, very little attention was at first paid to the forests. Later on the clearing of extensive tracts of forest or scrub jungle was definitely encouraged in an endeavour to repopulate many of the devastated districts. This was continued till more than half way through the nineteenth century, large tracts of land being given to grantees on condition that they cleared it, or at least part of it. Under the Waste Land Rules of 1880, the forests of Oudh were divided into allotments of 5,000 acres each. These were made over to men of supposed enterprise to be cleared for cultivation, under favourable terms as regards revenue taxes. The only condition was that they should cut down one-quarter of the forest and bring one-quarter of the land under cultivation within a period of 12 years.

Some of the plots were sold outright; others were sold on the instalment system; while a few could not be disposed of at all. Few of the grantees or purchasers either brought the required area of land under cultivation, or paid the due instalments of their purchase money. This was partly due to many of them being just adventurers, who simply intended to make what they could out of the grants. This they did by selecting and felling only the best trees, or more simply by leasing out the right to fell trees to contractors, who only took the cream of the forest. But it was also due to the inherent difficulties which faced even the most sincere of them, who honestly tried to clear and cultivate the land, but all too frequently failed.

The initial cost of clearing the forest was considerable, as the price of timber in those days *in situ* was nil, and the water carriage

available was limited to the tracts of forest immediately on the banks of the rivers. Further, the difficulty of inducing tenants to settle in these dismal solitudes, at that time haunted by tigers and wild elephants, was enormous. In many cases also, indigo was cultivated, and then later on the development of the synthetic dye industry in Europe killed the Indian indigo trade, and areas which had once been cleared have again reverted to jungle.

The unsatisfactory carrying out of their obligations by the grantees and purchasers coincided with the development of a realisation that the forest resources of India were being too thoughtlessly squandered, and that India was in many places already too depleted of forests. Resumption by Government of many of these lands therefore took place, and a policy of forest conservation, not of forest destruction, was adopted.

The South Indian Forests.—This need for conserving the forests of India was actually first realised in the South, where although the general history had been similar to that in the North, the destruction of the forests had been less felt.

Another factor had, however, come into play, namely the existence in the southern forests of valuable trees, such as teak and sandal, satinwood and ebony. These had for centuries been known to the western markets, and had been exported in large amounts to Arabia and Persia. The Arabs had a powerful fleet, for which teak timber was used. Teak and sandal were, therefore, declared "royal trees" by the various rulers (e.g., by Tippoo Sultan). But this did not suffice to protect them, as the rulers simply leased out the forest blocks to traders who removed much of the best timber.

The annihilation of the power of Tippoo Sultan, by the conquest and partition of Mysore, put extensive forest regions at the disposal of the British Government. At about this time also, the excessive consumption of oak by the great increase of British shipping had caused an alarming scarcity of that valuable timber, especially for the British navy and the East India merchantmen. A substitute was, therefore, searched for, and in teak an admirable substitute was found. "Beautiful and durable specimens of naval architecture" were supplied from the dockyard at Bombay, both frigates for the navy and merchantmen for the East India Company.

One of the first, by the Master-Builder Jamsetjee, was the frigate *Salsette*, which when frozen up for nine weeks in the Baltic, stood unhurt such buffetting of the ice as other ships would not have stood for one day.

The growing need for teak, then, for the navy and for the merchantmen, caused an investigation to be made into the available supplies in the South Indian forests. This led to the discovery that the vast resources of the Indian forests, that it had been customary to believe in, did not in fact exist. Past exploitation had caused a serious dearth of good timber, and systematic management was urgently needed if a sustained supply was to be ensured for the future. One of the great advocates for the protection of the teak forests in that part of India, and also for their extension by plantation, was Mr. Conolly, who as Collector of Malabar in 1843 started the well known Nilambur teak plantations.

The annexation of the Pegu part of Burma in 1852 appeared for a time to solve the teak problem, as there were apparently inexhaustible supplies of Burma teak, but Dr. Brandis (afterwards Sir Dietrich Brandis), who was appointed Superintendent of the Pegu forests in 1856, carried on a determined struggle with the mercantile community of the province to save the Burma teak forests from the fate of the South Indian teak.

Both in the North and in the South of India, then, and also in Burma, there arose in the second half of the nineteenth century a realisation that India's forest wealth was by no means unlimited; protection and conservation, improvement and extension, were needed in many parts of the country; and in that realisation was born the present Forest Department.

REFERENCES

EDWARDES, S. M.—"Sidelights on Maintenance of Forests in Ancient India," *Empire Forestry Journal*, Vol. 5, No. 1, 1926.

MC DONNELL, J. C.—"Early Days of Forestry in India," *Empire Forestry Journal*, Vol. 8, No. 1, 1929.

MONEY, W. T.—"Extracts from Observations on the Expediency of Shipbuilding at Bombay for the Service of His Majesty, and of the East India Company," *Indian Forester*, Vol. LVI, No. 12 (December, 1930) and Vol. LVII, No. 1 (January, 1931).

PERRÉE, W F.—"Indian Forest Administation," *Empire Forestry Journal*, Vol. 6, No. 2 (1927).

STEBBING, E. P.—"The Forests of India," Vol. 1.

WORKING PLANS—Various, more particularly those of the Gorakhpur, South Kheri and Saharanpur Forest Divisions, United Provinces.

THIS DEMONOCRACY

The bureaucrats sit in their big office chairs
In Bombay and Delhi, and none of them cares
If the hopes of the humble take to themselves wings—
Like Pilate, they care nowt for all of sich things.
If a question arises concerning the war
Of some nature and type that they ain't heard afore,
They will thump on a bell and just let out a holler—"See
What was it we wrote in our GENERAL POLICY?"
Now a blighter I know
Was a young D. F. O.
Just a score (meaning twenty) of odd years ago,
And at once on the outbreak of war his petition
To serve in the Army, received the permission
Of those most concerned, viz., *to wit, or to say,*
The Government ruling the roost in Bombay,
Sec. of State, the Chief Secret'ry, and *Chief Conservator—*
All corresponding around the world's curvature
And reaching agreement as never before,
That the said D. F. O. might shove off to the war.
But alas and alack, there is often a slip
Twixt the bottle and glass, and the glass and the lip,
And the War Office told him "There's no room to-day—
In six *months, or* nine *months, or* twelve *months, we may*

Be requiring your service in aid of the State—
But meanwhile (we regret it!) you'll just have to wait."
The D. F. O. said, "Though I may be a fool,
I know half-pay plus no-pay won't keep sons at school—
If you can't take me now, as a jolly good pal,
I shall have to return through the Suez Canal!"
There followed a phase of peculiar war
When the world carried on very much as before,
And ev'rything grew in the garden so fine—
Though no washing appeared on the great Siegfried Line.
And then all of a sudden—well into the Spring—
When no one was thinking of any such thing—
It happened quite suddenly out of the blue—
And before we well knew it the Nazis were through!
First Norway, then Holland, then Belgium, then France—
Like ninepins they fell, and the world looked askance,
No longer assured that there was not a chance
Of Germany coming out top of the dance!
(Of course, we had been far too readily lured
By the satisfied cry "VICTORY IS ASSURED!"
Now replaced—thank the Lord, and not one found to rue it—
By the far better slogan "Wake up, and GO TO IT!")
We return to our hero, who, always a stoic,
Remained on in India, far from heroic,
Selling billets of sandalwood just as of yore—
And performing no service concerned with the war.
To him came a cable, disturbing his peace—
"If enjoying good health please arrange your release,"
Signed—"Troopers"—the War Office General who stoops
To the task (none more vital) of furnishing troops—
A task which in these days, whatever the pangs,
Must mean combing out tail-hairs to strengthen our fangs.
Well, that reader is right who would readily guess
That the message at once was repeated express,
To Department, to Government Bombay, et cetera!
The D. F. O.'s prospects grew instantly betterer!
None could retain him on retailing scent
To Parsi fire-temples, when urgently meant

To report to the Battle Shack! Even bureaucracy
Would not restrain him from aiding democracy!
Surely our Government knew white from black?
The D. F. O. thought *so, and started to pack.*
One month passed wearily, nothing was done—
Suspension on tenterhooks never was fun.
Two months went by: while ships rounded the Cape,
The case of our hero, festooned with red tape,
Was submitted to Delhi: God knows, t'would be treason
To even suggest there was no earthly reason
For troubling the great tub of Delhi? Diogenes
Should not be made sponsor for other folk's progenies—
And even philosophers tend to get riled
When asked to adopt some importunate child!
And this child was *importunate, greatly, I fear,*
Being due any day now to reach Ballard Pier,—
And in war-time of course it is no joking matter
To miss any rare sailing and wait for a latter.
Time and tide wait for no man, and nor does a war—
If he loses a chance he may get it no more,
And yet any attempt to take Time by the fore-
Lock, tends to make Government India sore.
"Who the devil," they say, "Is this blighter who wires
That his case is so urgent? And patience expires,
And an answer in language impeccably civil
Is sent to inform him to go to the devil!
Thus: "Government India deeply regret
That they can't see their way to release you, my pet,
To take part in the war going on overseas—
Since you have to sell scent to decrepit Parsis."

* * * *

It is finished. The curtain descends on that joke,
And an awkward conundrum is solved by a stroke.
Civil servants, you see, are remarkably rare,
And not one *can a Government possibly spare:*
While as for their former and previous consent
In the case of our hero—it never was meant'

Like Topsy, it growed unbeknown in the night,
And by cancelling now they just put matters right!
However, lest any ill-feelings appear
Over trifles of honour that some men hold dear
Though never in office hours,—here ends the tale:
"The said D. F. O. is permitted to sail
On long leave. His assistant may serve on the spot—
But we withold permission for him to be shot.
He may do what you will—we have said it before—
Provided he does not engage in the war!"

H. J. C. M.

ON THE FLORA OF CHITTAGONG

BY M. B. RAIZADA, ASSISTANT BOTANIST,

Forest Research Institute, Dehra Dun

The present paper deals mainly with a collection made in 1939 and 1940 in various parts of the Chittagong Collectorate and Hill Tracts by Mr. T. V. Dent, I.F.S. In addition some of the plants referred to in this account were obtained by Mr. C. E. Parkinson during a tour in Chittagong in connection with the identification of trees on the Linear Sample Plots. Mr. V. S. Rao, I.F.S., has also on several occasions sent in specimens collected from the same region for identification and these have also been included in the present enumeration.

Our knowledge of the vegetation of Chittagong is based chiefly on the earlier collections of Roxburgh, Bruce (Wallich's collector), Hooker & Thompson, Clarke, King, Gamble, Wood and specially Lister and the native collectors of the Royal Botanic Garden, Calcutta. During recent years much valuable information has been added regarding the flora by Messrs. Shebbeare, Cowan, Macalpine and other forest officers of Bengal. The knowledge of the flora thus obtained, in itself very valuable, is still far from complete. The hilly tracts of Chittagong, though included within the political boundaries of Bengal, belong geographically to Indo-China rather than to India. As pointed out by Prain in *Bengal Plants* the

Chittagong flora has distinctive features of its own which exhibit a relationship with the flora of Arakan but incorporates within it a number of plants which are now properly considered to be purely Assamese.

Apart from the "List of Plants of the Chittagong Collectorate and Hill Tracts," prepared by Heinig in 1907, there is no work dealing exclusively with the flora of Chittagong and for a knowledge and identity of the plants found in that area recourse must be had to *The Flora of British India* by Hooker, *Indian Trees* by Brandis, *Bengal Plants* by Prain and *Flora of British Burma* by Kurz.

The plants incorporated in the present communication are additional records not mentioned in any of the above works as definitely occurring in Chittagong. No claim is, however, made that this list is complete and final. From the number of fresh records quoted it will be realised that much botanical exploration still remains to be carried out in that outlying district.

Incidentally it may be mentioned that the following plants, *Hopea odorata* Roxb., *Colona flagrocarpa* (Cl.) Craib, *Erythropalum scandens* Bl., *Symplocos spicata* Roxb. and *Aporosa dioica* (Roxb.) Muell. Arg., though recorded from Chittagong by Brandis, have, through an oversight, been omitted from Heinig's list.

Talauma phellocarpa King (*Magnoliaceae*).

So far reported for Assam.

Mainimukh, Chittagong Hill Tracts, February, 1940, T. V. Dent.

Cyathocalyx martabanicus HK. f. and Th. (*Anonaceae*).

Previously reported from Burma and Assam.

Kasalong reserve, Chittagong Hill Tracts, 16th May, 1939, T. V. Dent, "A very tall tree; flowers 3/4 inches long."

Artabotrys speciosus Kurz (*Anonaceae*).

Reported so far from the Andaman Islands.

Nalbania, Chittagong Hill Tracts, 18th May, 1939, T. V Dent, "A large climber."

Desmos dumosus Saff. (*Anonaceae*).

Known from Assam, Burma and Malay Peninsula.

Tintilla, Kasalong reserve, Chittagong Hill Tracts, 15th May 1939, T. V. Dent, "Tall climber to tree tops. Flowers large, 3-in across, very sweet-scented."

Roydsia suaveolens Roxb. (*Capparidaceae*).

Previously recorded from N. Bengal, Bhutan, Assam and Upper Burma.

Mainimukh, Chittagong Hill Tracts, 3rd March, 1935, V. S. Rao, 5560.

Also collected by T. V. Dent from Mascumba. In the Dehra Dun Herbarium there is also a sheet from Kaptai, ex Herb. J. H. Lace, 2177.

Scolopia kermodei C.E.C. Fischer (*Bixaceae*).

Known so far from Burma and the Andamans.

Chittagong Hill Tracts, without precise locality, 14th March, 1936, V. S. Rao 5629 "Tree with branched thorns."

Xanthophyllum virens Roxb. (*Polygalaceae*).

Hitherto reported from Assam and Burma.

Bhomoriaghona, Chittagong Collectorate, 3rd February, 1936, V. S. Rao, 5733. Also collected from Kasalong reserve, by T. V. Dent.

A perfectly good species distinct from *X. flavescens* Roxb. but confused with it in the Flora of *British India* and *Indian Trees*.

Garcinia paniculata Roxb. (*Guttiferae*).

Known so far from Bhutan, Assam and Burma.

Hazarikhil, Chittagong Collectorate, 7th January, 1936, V. S. Rao, 5657.

Ochrocarpus siamensis Kurz (*Guttiferae*).

So far reported only from Arakan.

Ringkheong reserve, Chittagong Hill Tracts, 5th April, 1935, Range Officer, Dehra Dun Herb. No. 69796. "Tree full of yellow juice.

Ternstroemia penangiana Choisy. (*Ternstroemiaceae*).

Previously recorded from the Andaman Islands, Burma, Malay Peninsula and Cochin-China.

Mainimukh, Kasalong reserve, Chittagong Hill Tracts, 16th November, 1934, C. E. Parkinson, 4275. "Tree, flowers white with a reddish tinge."

Also collected by Rao and Dent from the same region.

Sterculia coccinea Roxb. (*Sterculiaceae*).

Known from Sikkim, Bhutan, Assam and Burma.

Chandraghona Road, South of Rangamatti, Chittagong Hill

Tracts, 1st July, 1939, T. V. Dent.

Sterculia angustifolia Roxb. (*Sterculiaceae*).

Previously reported from Martaban and Perak.

Mainimukh, Kasalong reserve, Chittagong Hill Tracts, 12th March, 1940, T. V. Dent.

Scaphium wallichii Sch. et Endl. (*Sterculiaceae*).

Hitherto reported from Assam (S. Lushai Hills), Tenasserim, Malay Archipelago, Cochin China and Sumatra.

Mainimukh, Chittagong Hill Tracts, 22nd March, 1940, T. V. Dent. Also previously collected by Macalpine from Mascumba.

Heritiera macrophylla Wall. (*Sterculiaceae*).

Previously recorded from Assam and Burma.

Cox's Bazar, Chittagong Collectorate, January, 1935, V. S. Rao, 5551, "A medium-sized tree growing on the foothills."

Buettneria aspera Colebr. (*Sterculiaceae*).

Known from Assam, Burma and the Andamans.

Tintilla, Kasalong reserve, Chittagong Hill Tracts, 16th May, 1939, T. V. Dent, "Climber on high trees."

Elaeocarpus petiolatus Wall. (*Elaeocarpaceae*).

Reported so far from Assam, Burma and Malaya.

Mainimukh, Chittagong Hill Tracts, February, 1940, T. V. Dent.

Picrasma nepalensis Benn. (*Simarubaceae*).

Known from Nepal, Bengal and Assam.

Tintilla, Kasalong reserve, Chittagong Hill Tracts, 15th May, 1939, T. V. Dent.

Also previously collected by Macalpine.

Ochna wallichii Planch. (*Ochnaceae*).

Previously reported from Assam, Burma, Andamans and Malay Peninsula.

Kasalong reserve, Chittagong Hill Tracts, 24th March, 1935, V. S. Rao.

Canarium resiniferum Brace (*Burseraceae*).

Known from Assam.

Kaptai, Chittagong Hill Tracts, August, 1939, T. V. Dent.

Euonymus javanicus Bl. (*Celastraceae*).

So far reported from Burma and Malay Peninsula.

Hazarikhil, Chittagong Hill Tracts, 29th August, 1936, V. S.

Rao, 5639, "Small tree with a capsular fruit."

Also collected by T. V. Dent from Kasalong and Ringkheong reserve.

Siphonodon celastrineus Griff. (*Celastraceae*).

Hitherto reported from the Rajmahal Hills, Sikkim and Burma.

Mainimukh, Kasalong reserve, Chittagong Hill Tracts, 14th November, 1934, C. E. Parkinson, 4259.

Also collected by Dent from Mascumba, Ringkheong reserve.

Xerospermum glabratum Radlk. (*Sapindaceae*).

Known from Assam and Burma.

Tintilla, Kasalong reserve, Chittagong Hill Tracts, 7th August, 1934, C. E. Parkinson, 4266.

Also collected by Rao from Mainimukh and Bhomoriaghona, and by Dent from Kaptai.

Millettia pachycarpa Benth. (*Leguminosae*).

Previously reported from N. Bengal, Sikkim, Assam and Upper Burma.

Sitapahar Range, Chittagong Hill Tracts, 16th April, 1935, Range Officer 28.

Also reported from Kasalong reserve.

Derris monticola Prain (*Leguminosae*).

Known from Sikkim, Assam and Burma.

Chittagong Division, without precise locality, Macalpine.

Caesalpinia sepiaria Roxb. (*Leguminosae*).

Indigenous and naturalised in various parts of India and Burma.

Nalbania, Kasalong reserve, Chittagong Hill Tracts, January, 1940, T. V. Dent, "Large climber with profuse masses of bright yellow flowers."

Cassia timoriensis Dc. (*Leguminosae*).

Known from Burma, Western Ghats and Malay Archipelago.

Kaptai, Chittagong Hill Tracts, 25th November, 1934, C. E. Parkinson, 4289, "Tree 25 ft. high, flowers yellow."

Also collected by Dent from Rangamatti.

Terminalia myriocarpa Heurck. and Muell. Arg. (*Combretaceae*).

Hitherto known from N. Bengal, Sikkim, Bhutan, Assam and Burma.

Mascumba, Ringkheong, Chittagong *Hill* Tracts, 28th November, 1934, C. E. Parkinson, 4310, "Tree 40—60 ft. high."

Jambosa ramosissima (Wall.) Cowan (*Myrtaceae*).

Known from N. Bengal, Sikkim Tarai, Assam and Tenasserim.

Bhomoriaghona, Chittagong Collectorate, March, 1935, V. S. Rao, 5570, "Small tree."

Eugenia thumra Roxb. (*Myrtaceae*).

So far known from Burma and Malay Peninsula.

Balukhali, Chittagong Collectorate, 10th April, 1936, V. S. Rao, 5694. Also collected by Rao from Bhomoriaghona.

Syzygium syzygioides (Miq.) Merr. and Perry (*Myrtaceae*).

Previously reported from Assam, Burma, Andamans and Nicobar.

Kasalong reserve, Chittagong *Hill* Tracts, 24th March, 1935, Range officer.

Also collected from Cox's Bazar by Macalpine, Bhomoriaghonia, by Rao and Mainimukh by Dent.

Eugenia grata Wight (*Myrtaceae*).

Hitherto reported from Burma, Malay Peninsula and Andamans.

Cox's Bazar, Chittagong Collectorate, 2nd June, 1931, Salahuddin.

Eugenia bracteata Roxb. (*Myrtaceae*).

Known from Assam, Western Peninsula and Orissa.

Cox's Bazar, Chittagong Collectorate, 10th April, 1932, Conservator of Forests, Southern Circle, Bengal.

The specimens quoted above are poor but appear to be correctly named.

Syzygium rhamphiphyllum (Craib) Fischer (*Myrtaceae*).

Known from Burma and Siam.

Bhomoriaghona, Chittagong Collectorate, 4th February, 1936, V. S. Rao, 5736.

Also reported from Cox's Bazar.

Homalium nepalense Benth. (*Samydaceae*).

Known from Nepal and Orissa.

Hazarikhil, Chittagong Collectorate, 24th April, 1936, V. S. Rao, 5690, "A medium sized tree."

Also collected at Mainimukh by Dent.

Alangium barbatum (R. Br.) Baill. (*Cornaceae*).

Previously known from Bhutan, Assam and Tenasserim.

Nalbania, Chittagong Hill Tracts, 18th May, 1939, T. V. Dent.

Mastixia arborea C. B. Cl. (*Cornaceae*).

Known from Assam and Western Ghats.

Mainimukh, Chittagong Hill Tracts, 1939, T. V. Dent, "A tall tree."

Nyssa bifida Craib (*Cornaceae*).

Previously known from Assam, Burma and Siam.

Bhomoriaghona, Chittagong Collectorate, 10th April, 1935, V. S. Rao, 5587, "Medium-sized tree."

Randia cochinensis Merr. (*Rubiaceae*).

Known from Assam, Burma, Malay and Cochin-China.

Bhomoriaghona, Chittagong Collectorate, 27th April, 1935, V. S. Rao, 5573, "Small tree, blaze slightly yellow."

Ixora pubirama Brem. (*Rubiaceae*).

Previously known from Burma.

Sitapahar Range, Chittagong Hill Tracts, 3rd April, 1935, Range Officer 27.

Ixora goalparensis Brem. (*Rubiaceae*).

Hitherto reported from Assam.

Tintilla, Chittagong Hill Tracts, 16th May, 1939, T. V. Dent. This is not typical I. *goalparensis* Brem. but a variety.

Morinda citrifolia Linn. (*Rubiaceae*).

Wild or cultivated in various parts of India.

Nalbania, Chittagong Hill Tracts, 18th May, 1939, T. V. Dent.

Psychotria fulva Ham. (*Rubiaceae*).

Known from Assam and Burma.

Hazarikhil, Chittagong Collectorate, 28th November, 1935, V. S. Rao 5661, "Shrub in moist situations."

Lasianthus andamanicus HK.f. (*Rubiaceae*).

Previously known from Burma and Andamans.

Hazarikhil, Chittagong Collectorate, 1st September, 1935, V. S. Rao, 5624.

Eupatorium odoratum Linn. (*Compositae*).

Native of the West Indies, naturalised in Bengal, Assam, Burma and Andamans.

Bhomoriaghona, Chittagong Collectorate, 5th December, 1934, C. E. Parkinson, 4313.

Also collected from Kaptai by Champion.

Synedrella nodiflora Gaertn. (*Compositae*).

Previously known from Bengal, Assam, Burma and Andamans.

Cox's Bazar, Chittagong Collectorate, 9th December, 1934, C. E. Parkinson, 4337.

Agapetes grandiflora HK.f. (*Vacciniaceae*).

Hitherto reported from Assam.

Bhomoriaghona, Chittagong Collectorate, 26th November, 1933, H. G. Champion, 1114, "Epiphyte in Garjan forest."

Diospyros pilosula Wall. (*Ebenaceae*).

So far known from Assam, Burma and Andamans.

Hazarikhil, Chittagong Collectorate, 26th April, 1936, V. S. Rao, 5641.

Also collected from Mascumba by Dent.

Diospyros nigracans Wall. (*Ebenaceae*).

Known from Assam.

Mainimukh, Chittagong Hill Tracts, 11th May, 1939, T. V. Dent.

Linociera macrophylla Wall. (*Oleaceae*).

Known from Assam, Burma and Andamans.

Mainimukh ?, Chittagong Hill Tracts, February, 1940, T. V. Dent.

Melodinus monogynus Roxb. (*Apocynaceae*).

Previously recorded from Assam, Malay Peninsula, China and Siam.

Kasalong reserve, Chittagong Hill Tracts, 30th March, 1935, Range Officer.

Rhynchodia verrucosa (Bl.) Woodson (*Apocynaceae*).

Known from Assam, Burma, Tonkin, Hainan, Siam and Malay Peninsula.

Nalbania, Chittagong Hill Tracts, 18th May, 1939, T. V. Dent. "Large woody climber, corolla creamy white."

Vandellia hookeri Clarke (*Scrophulariaceae*).

Known from Bihar, Bengal, Assam and Burma.

Sitapahar Range, Chittagong Hill Tracts, 25th November, 1934, C. E. Parkinson, 4286.

Strobilanthes phyllostachys Kurz (*Acanthaceae*).

Known from Burma and Andamans.

Chittagong Hill Tracts, December, 1937, Range Officer.

Strobilanthes auriculatus Nees var. *edgeworthiana* (*Acanthaceae*).

Known from various parts of India.

Chittagong Hill Tracts, 27th November, 1935, V. S. Rao, 5676.

Myristica kingii HK.f. (*Myristicaceae*).

Hitherto known from Bengal, Sikkim and Assam.

Bhomoriaghona, Chittagong Collectorate, 4th February, 1936, V. S. Rao, 5647, "Tree with red juice."

Cinnamomum cecidodaphne Meissn. (*Lauraceae*).

Known from N. Bengal, Sikkim, Assam and Burma.

Mainimukh, Chittagong Hill Tracts, 25th February, 1934, Macalpine.

Machilus fruticosa Kurz. (*Lauraceae*).

Hitherto known only from Burma.

Sitapahar Range, Chittagong Hill Tracts, 26th December, 1934. Range Officer.

Litsaea semicarpifolia Wall. (*Lauraceae*).

Previously reported from Bengal, Assam and Burma.

Bhomoriaghona, Chittagong Collectorate, 26th November, 1933, H. G. Champion, 1120.

Also collected from Hazarikhil by Rao.

Cnesmone javanica Bl. (*Euphorbiaceae*).

Known from Assam, Bengal, Burma, Malay, Sumatra and Java.

Kasalong reserve, Chittagong Hill Tracts, 13th May, 1939, T. V. Dent, "Stinging climber in bushes."

Morus laevigata Wall. (*Moraceae*).

Known from various parts of India.

Rangamatti, Chittagong Hill Tracts, July, 1939. T. V. Dent, "Large tree."

Quercus mespilifolia Wall. (*Fagaceae*).

Known from Assam and Burma.

Bhomoriaghona, Chittagong Collectorate, 26th November, 1933, H. G. Champion, 1118.

Quercus polystachya Wall. (*Fagaceae*).

Known from Assam and Burma.

Bhomoriaghona, Chittagong Collectorate, 26th November, 1933, H. G. Champion, 1121.

In the absence of fruits the above identification is only tentative.

Ophiopogon intermedius Don. (*Haemodoraceae*).

Mainimukh, Chittagong Hill Tracts, 10th April, 1939, T. V. Dent, "Very common on river banks."

Smilax aspericaulis Wall. (*Liliaceae*).

Known from Bengal, Sikkim, Assam, Burma, Andamans and Malay Peninsula.

Bhomoriaghona, Chittagong Collectorate, 6th December, 1934, C. E. Parkinson, 4317.

Mapania silhetensis C. B. Clarke (*Cyperaceae*).

Previously recorded from Silhet.

Bhomoriaghona, Chittagong Collectorate, 6th December, 1934, C. E. Parkinson, 4315, "A stemless herb found in swampy ground; leaves 5 ft. long."

EXTRACTS

THE CONTROL OF WEEDS

BY S. CHOWDHURY, B.SC. AGRI., ASSOC. I.A.R.I.

The farmer has a number of enemies. Weeds are one of them. They decrease the value of grain and seed crops, interfere with the growth and use of forage crops, and add enormously to the cost of crop production. Many weeds are conspicuous in our fields, gardens and lawns, and their presence highly depreciates the value of such lands. Some weeds are poisonous either when eaten or when handled and some impart an unpleasant flavour to dairy products. Moreover, weeds very often harbour in their roots, stems and leaves, insects, fungi and bacteria, which are the causes of the numerous diseases of our crop plants. From all these considerations the growth of weeds on the farm is highly undesirable.

We are prone to take weeds for granted. Yet some orchards and farms, large and small, have so effectively combated weeds, by carefully applying the best known methods of control that now their fields are clean, their seed is clean and the usual losses attributed to weeds are reduced to a minimum. It can safely be stated that the

* Vide *Indian Forester*, Vol. LXVII, No. 2, p. 88.

losses annually suffered by the cultivators due to weeds can largely be eliminated by following the best known methods of weed control.

The Conflict of Life

In nature there is a hard struggle for existence. The unlimited spread of organic life is held in check through unfavourable conditions of the environment and by the struggle which goes on continuously between different individuals of the same species of plants, between the individual of one plant species and those of the other species of plants, and between certain plant species and animal species. All plants in nature are contending for some place in which to live and multiply. The more successful the invasion, the more inimical they are to other plants. Living organisms become a pest when their growth remains unchecked. They overrun the fields and we call them weeds. Man after centuries of hard toil has cleared the jungle land for his agriculture. But the jungle is all the time claiming its own; it is trying to ramify and invade the cultivated areas of the farmer. And the farmer must remember that he has to maintain an incessant fight by slowly gaining knowledge of how to keep down weeds. It requires the same persistence on his part now as in the past. If there is a slight slackening on his part he will find his crop overpowered by weeds.

Weeds and the Damage they Cause

Weeds are plants that are undesirable and hence not wanted by the farmer in his field, garden or lawn. Any plant may be a weed at times. A potato or a maize plant is a weed when it volunteers in other crops and becomes a nuisance.

Few people, probably, ever realise what a burden weeds add to human existence. The production of almost all crops largely consists of a battle with weeds. The preparation of many products of the soil for human consumption involves the elimination of weeds and their effects. Weeds may cause illness or even death in man or animals. They militate against our full enjoyment of the outdoors; they are the bane of every home owner and amateur gardener. Few human activities, in fact, are not affected in some measure by weeds . . . . pests which increase the cost of our food and clothes, hamper our movement, menace our health and dampen many of our pleasures.

Weeds cause damage in many ways, the more important of which are as follows:

(1) Weeds offer serious competition to crops for plant food and moisture. Probably the heaviest loss by weeds results from their competition with crops for plant food and moisture. The crop-producing power of most of our agricultural soil is limited either by the plant-food or moisture available. When the crop must share this limited supply with weeds, the inevitable result is lower yields.

(2) Weeds 'crowd' the crop restricting the amount of light, heat and air necessary for healthy growth and for the proper assimilation of plant food. The effect is to hamper the growth of the plants during early life. The straw of cereals may be weakened and rendered liable to 'lodge' thus making the work of cutting at harvest both difficult and expensive.

(3) Another heavy tax incurred through weeds is the large amount of labour and equipment necessary to keep weeds in check in those areas where they would seriously interfere with crop production.

(4) Weeds increase the cost of preparing many crop products for consumption. After the crop is grown weed contamination of the product may involve further expense in handling and processing. This is especially true of the seed crops of rice, wheat and other cereals. Most of the seed crops grown by our cultivators are contaminated with weed seed which must be removed before the seed can be used.

(5) Weeds impair the quality and destroy or reduce the value of many products of the soil. Weed contamination of many crops reduces their quality and market value. The market value of rice may be greatly reduced by the presence of certain weed seeds.

(6) Weeds serve as hosts for many fungus and bacterial diseases and for insect pests which prey on crop plants. Thus they aid in the propagation of such crops enemies which they render more destructive and more difficult to control. The bacterial organism causing bean blight lives on some of the wild legumes. Many insect enemies of crop plants may be carried over on weeds during periods when crops are not available. Nematodes and grasshoppers, so destructive of many crop plants live and multiply on many weeds. If, in fact, weeds and other uneconomic plants could be eliminated

the control of many of our worst crop pests would be greatly simplified.

(7) Weeds are sometimes poisonous and many endanger the health or life of men and animals. Many domestic animals are lost annually from weed poisoning. The health of human beings may also be affected by weeds. Deaths occasionally occur from the eating of seeds, berries or tubers of poisonous plants.

Characteristics of Weeds

Of the many thousands of different kinds of plants in the world, fortunately but a relatively small number are weeds. The world contains some plants with a combination of characters such that they become pests; they tend to grow where not wanted; they resist man's efforts to combat and subdue them; they may resist frost, high temperature, and drought; they may be able to grow under a variety of soil and climatic conditions; they may produce enormous numbers of seeds which may live for many years in the soil; and they usually multiply and spread very rapidly. Of course, any one plant does not necessarily have all the characters which from our standpoint are undesirable but it may have a sufficient number to be a pest. Any plant which seed prolifically or reproduces vegetatively from underground parts or is poisonous to livestock or human beings or causes mechanical injury, may become a *noxious weed.*

Many weeds produce an enormous number of seeds; this truth is shown below:

Species	Approximate number of seeds per plant.
Tumble weed ...	... 6,000,000
Tumbling mustard ...	... 1,500,000
Purslane ...	... 1,250,000
Water grass ...	... 980,000
Lamb's quarters ...	... 608,000
Crab grass ...	... 204,000
Russian thistle ...	... 200,000
Black mustard ...	... 143,000
Buckthorn ...	... 118,000

The seeds of many weeds retain their vitality for many years especially when buried in the soil. For example the seeds of Shepherd's purse, mustard, purslane, pigweed, mayweed, dock and

chickweed are known to live more than 30 years buried in the soil; morning glory 25 to 30 years; ragweed 1 to 5 years. Ploughing may turn weed seeds under, placing them at depths where there is insufficient oxygen to enable them to germinate; there they remain for many years, until finally a later ploughing brings them again to the surface where they germinate. Thus a field which has for years been relatively free may suddenly develop a crop of weeds.

Manner of Introduction and Spread of Weeds

Before the eradication and control of weeds can be intelligently dealt with, it is essential to have a clear conception of the manner in which weeds obtain access to the farm, and the methods by which they are spread amongst cultivated crops. In any particular locality weeds may come from neighbouring farms, from other areas in the district or province, from other countries. Time and time again a certain weed has been introduced into a locality, the infestation at first being confined, possibly to a few square yards or represented by only a few individual plants; and because of ignorance, indifference, neglect or improper methods of control, the small infestation forms the nucleus for a wider one which may spread throughout a whole country. The manner of introduction and spread are very varied, but amongst the commoner processes are:

(1) Probably the most common and effective means of introducing weeds is by the sale and distribution of *impure commercial seeds.*

(2) The introduction of weeds into new localities is strikingly often traceable to operations connected with transportation by means of rail or ship of agricultural plant or animal produce. Seeds are conveyed in screenings, in baled hay, in the packing about trees and in feed stuffs. As these materials are transported from place to place by railway, cars or trucks, portions may jostle out and scatter seeds along the way. Some weed seeds which may occur in screenings, baled hay or other feed stuffs will pass through the digestive tracts of animals unharmed and consequently be spread on the field in manure.

(3) Weed seeds are conveyed in dirt and sand which are transported from place to place and employed in construction work, such as embankments, fills and grades.

(4) Weed seeds are distributed by means of mud and dirt on the feet of animals, farm labourers, the wheels of vehicles or the rubber casings of automobiles.

(5) Weed seeds are introduced from one farm to another by means of farm carts, implements, threshing machines, etc. The seeds stick on to the tyres of carts, the bodies of ploughs and they drop off at the time of cleaning or using them. Some weeds are dragged by ploughs, cultivators and harrows from one area to another. Plants like the bindweed, *Clerodendron Phlomides, Aristolochia bracteata* may occur in patches in a field and when it is ploughed the underground stems and roots get broken and spread all over the field, infecting the whole area.

(6) Farmyard manure is often the chief source of contaminating fields with weeds. Cattle go out for grazing to all sort of waste places where weeds are abundant and feed on them. The hardy seeds are excreted undigested in the dung which is stored and applied to fields.

(7) Some weeds are adapted for dispersal by wind, some by water and some by animals. Plants of the *Compositeæ* family have usually *pappus* or *tufts* of hairs on the top of the small seed-like fruits. These hairs enable the fruits to travel very long distances by the help of the wind. Water also aids the despersal of weed seeds. A great number of weed seeds will float on water, which, in the irrigated sections is known to be one of the most important means of spreading weeds. The seed of *Nymphaea* is enclosed in a sac-like structure in which is enclosed a small air bubble which helps the seed to float and travel for some time and when the air bubble escapes the seed sinks down under water. Fruits of *Xanthium strumarium* are carried over long distances by water.

Birds, animals and man are also responsible for the introduction and spread of weeds. The seeds of *Croton sparsiflorus* somewhat resembles beetles and may be picked by insectivorous birds and thrown away when they are found to be useless. *Abrus precatorius* has very brightly coloured seeds that are exposed when the pod breaks open and attract the attention of birds. Fruits of *Tribulus terrestris* are provided with sharp spines that run into the soles of barefooted pedestrians who remove them at once and throw them

away thereby doing a service to the weed. In *Achyranthes aspera* the old fruits point downwards exposing the spine-tipped bracteoles that easily get caught on the clothing of people passing by or on the skin of animals and are carried and dispersed by them. *Pupalia atropurpurea, Tragus racemosus, Triumfelta rotundifolia* have hooks on the fruit coats or on the bracts that help dispersal by the agency of animals like sheep and goats.

Factors which Influence the Spread of Weeds

Various factors favour the abundance, increase and spread of weeds, and these although more or less interrelated may be grouped under the following heads:

(1) *Deforestation.*—Forests often attain such density that they cut off so much light as to insure the absence of all undergrowth. But when the latter are cut down the undergrowth grows with greatly increased vigour and if once allowed to develop is more difficult to subjugate them.

(2) *Pasture Methods.*—Few conditions are more favourable to the spread of *obnoxious weeds* than the open unrestricted grazing. The animals wander to and fro distributing the burred, prickly, hairy or adhesive seeds of various weeds as they go and continually select and eat out the better pasture plants. Obnoxious, prickly, woody and poisonous plants are usually left untouched by healthy, wellfed stock and their growth is favoured by the continual grazing of the good fodder plants . . . . the weeds are favoured and the useful plants are suppressed.

(3) *Grass and Forest Fires.*—The action of these in favouring the spread and increase of weeds is two-fold. In the first place, the removal of the original vegetation provides the conditions and in part acts as a stimulus to the germination of the seeds of weeds lying dormant in the soil. In the second place burning off the vegetation means a loss of humus. Repeated fires favour the survival of plants whose demands are easily satisfied, and which have either air-borne or long-lived seeds. To this class most weeds belong. Its modest demands enable the weed to develop on an impoverished soil, on which long-lived seeds are ready to spring up as soon as the way is cleared for them while air-borne seeds are continually carried to the newly-cleared ground from neighbouring unburnt areas.

(4) *Drought.*—With very few exceptions no economic plants of any great value show a pronounced power of resistance to drought conditions. Most cultivated plants suffer severely, and are stunted and dwarfed, even by moderate drought. But on the contrary temporary periods of very severe drought favour rapidly growing and freely seeding weeds, or plants perennating in dry periods by means of underground bulbs or tubers. Less intense, but more prolonged and generalised drought conditions favour deeply rooting permanent weeds and encourage the survival of scrubby, spiny, or more or less leafless shrubs as well as of a few drought-resisting trees.

Classification of Weeds

There is no one basis for the classification of the weeds. They can hence be classified from different points of view. They may be classified as *terrestrial* and *aquatic* according as they grow on land or water; as *indigenous* or *introduced* as they are natives of the locality or introduced from elsewhere; as weed of the *paddy land, waste land,* weeds of *play-grounds* and *roadsides*, weeds of *lawns,* etc., according to the nature of the land they infest; as weeds of *red soils, black cotton soils, light, sandy soils* from the types of the soil on which they are usually found and in a number of other ways. But from the practical point of view it will be found convenient to classify weeds as *annuals, biennials* and *perennials* according to the length of time the weed lives.

(1) *Annuals.*—Annual weeds are those which live but one year, they produce seed but once and then die down entirely, root and all. These are usually small herbs with shallow roots and weak stems. An annual has no parts underground by means of which it is capable of spreading; it propagates itself by seeds alone which they often produce in great profusion. After seeding the annuals die away and the seeds germinate and start the next generation in the season or year following. Thus the cycle goes on year after year. Plants of this type are *Argemone mexicana, Stemodia viscosa* and many others. In fact most of our common weeds are only annuals.

(2) *Biennials.*—A biennial weed is one which lives two years producing seed at the end of the second year. It is doubtful whether there are many biennials among our weeds.

(3) *Perennials.*—To this class belong some of our worst weeds. They are very well adapted to withstand adverse conditions. Plants of this group, as contrasted with *annuals* and *biennials*, live three years or more and spread not only by seed but also by the underground stems and root-suckers. *Cyperus rotundus, Convolvulus arvensis, Aristolochia bracteata* are some of the common examples.

The Problem of the Destruction of Weeds

Weeds do great damage and good agricultural practice, therefore, necessitates their speedy destruction. From the very beginning of agriculture man has tried means after means for the control of weeds, but in most cases, his attempts have failed either wholly, or, if lucky, partly. There is nothing to be astonished at this failure. The problem of the destruction of weeds is a difficult task, and it cannot be solved by following all haphazard methods hitherto tried by the farmers. The first and the most important step in the destruction of weeds is the acquirement of detailed and definite knowledge of the life-history of the weed. If a farmer gains the knowledge of the life-history of a weed, he knows the 'weakest' point in the life of that plant and can easily check it. Before attempting any measure of control the following information should be gathered about the weed with great care and caution:

(1) When does the weed germinate, *i.e.*, when is it first seen appearing above the soil?

(2) When does it flower and bear fruits and seeds?

(3) With what special crop or crops it is particularly associated?

(4) What is its general effect on the crop? and

(5) Can it be utilised for cattle fodder or for any other purpose?

If a farmer studies these few simple things about the weeds that are found on his farm for at least two consecutive years, he will know everything about the life-history of those weeds, and will be in a better position to devise means for their destruction than when he was ignorant about these and tried means at random.

Eradication of the Weeds

There are four possible methods that can be tried for the eradication of weeds. They are as follows:

(1) By the introduction of a parasite which is either a fungus or an insect.

(2) By the spraying of herbicides, *e.g.*, copper sulphate, salt, carbolic acid, kerosene, sulphuric acid, etc.

(3) By the application of steam.

(4) By mechanical collection and destruction.

Fungus and Insect Parasites

The control of weeds by fungus or insect pests is not simple. Though recently spectacular results have been obtained in the control of prickly pear in Australia by means of a pyralid moth *Cactoblastis cactorum* aided by two other insects *Dactylopus tomentosus* and *Chelinidia tabulata* still it is largely in the experimental stage, and, at least can only be used against a very limited number of plants without any danger. As a rule the plant-feeding insects, fungi, or bacteria are not highly specialised in relation to their hosts. Most of these organisms have a wide range of hosts. It has very often been seen that an insect, a fungus or a bacterium employed to control a certain weed has turned its attention to some other plant of great economic importance. Thus *Thecla echion* imported into Hawaii to destroy the flowers of Lantana has been found to attack brinjal, an absolutely unrelated plant, one being a *verbena* and the other a *solanum*. Besides the parasitic nature of these organisms has been found to be much influenced by the environment. Very often strangely different habits are observed in the same organism, only due to a change in their environment. In the case of the beetle *Elytroteinus substruncatus* it has been seen that in Fiji it bores into the stems of begonias but in Hawaii the same insect is a pest of ginger, and in the Cook Islands is recorded as attacking lemons.

Again, an insect or a fungus that attacks the young shoots of the plant and causes die back, may, if the attack is not sufficiently serious or is only seasonal, lead to branching and render the plant more densely shrubby, leading to a greater flowering and seed production.

Yet another danger in biological control of weeds is that when the weed to be controlled covers large areas, and the controlling agency is one which actually kills the plant, the result of the introduction, if successful, is the sudden opening up of these areas for colonisation by other plants. The plants most likely to take advantage of these newly-opened lands are other weeds. In Australia where control of prickly pear by biological agencies has been so suc-

cessful, it has been found that if fire runs through the masses of dead pear a dense growth of Mallee type comes up, even more difficult to handle than the weed was. In Fiji also, on certain waste areas *Clidemia hirta* is being replaced by *Stachy tarpheta* and *Solanum torvum*, weeds far worse than the former.

A consideration of the above dangers will manifest the limited scope of biological methods in weed control. It is very safe, therefore, to conclude that biological methods in controlling weeds should be tried only when other methods have been completely exhausted.

Herbicides

Chemicals have been used extensively and are also used to-day in some countries for the killing of weeds. And it has been reported that, in numerous instances, chemicals intelligently used have been found more expeditious and economical in the destruction of weeds than any other means for weed eradication.

Any soluble chemical, even including the various commercial fertilizers, if used in sufficient amount, will kill plants. On the basis of their type of action the herbicides can be classified as follows:

(1) First substances which by their osmotic action plasmolyze cells and prevent plant so treated from obtaining water. An example of such a substance is common salt.

(2) A second class includes those chemicals which by their physical action dissolve or dilute protoplasmic constituents and disorganise the cell by changing its permeability and other physical properties; substances belonging to this class are the hydrocarbons.

(3) A third type includes chemicals commonly called 'protoplasmic poisons' which kill enzymes, coagulate proteins or combine with other constituents of the protoplasm and bring about a cessation of the life-processes in the cells. Examples of chemicals belonging to this group are mercuric chloride, cyanides, copper salts, iron salts, etc.

(4) A fourth type includes gaseous poisons like sulphur dioxide. These react with the respiratory pigments of plants and interfere with the oxidation reduction balance in cells. The *'respiratory chromogens'* are either completely oxidised or decreased in number. The cells fail to take in oxygen and consequently life-processes come to a standstill.

There are a large number of chemicals that are available for utilization as herbicides. But effectiveness, cheapness, and convenience of application are the things to determine choice among the various compounds available. Without attempting to list all of these, we include those whose worth has been best established by trial:

(1) *Sodium chloride.*—Salt is more commonly used than any other compound, chiefly because of cheapness and handiness. It should be applied dry or in strong solution; and it is most effective in hot, dry weather.

(2) *Copper sulphate.*—This is more powerful in herbicidal action than salt, but its cost prohibits its general use. For most purposes it is best used in solution, 2 to 10 per cent. being effective.

(3) *Kerosene.*—This and other coal-oil products will kill plants. Because of handiness it is frequently used, but it is weak in efficiency, relatively more costly than some of other common chemicals. A pint of crude carbolic acid will do better service than two gallons of kerosene, and costs much less.

(4) *Carbolic acid.*—This is one of the quickest and most valuable herbicides. The crude acid is relatively cheap. It is not quite equal to the arsenical poisons for penetrating the soil or in lasting effects, but it is often preferable because of cost or convenience. An effective method is to squirt the strong acid from an ordinary oil can on the roots or crown of individual weeds. If it is to be sprayed or sprinkled broadcast on the foliage or ground, it should be diluted with 15 to 30 parts of water and this mixture agitated frequently during use.

(5) *Sulphuric acid.*—This, of course, is destructive to everything it touches. It can be applied in the crown or about the roots of coarse or specially hardy plants. Aslander lists upwards of 50 species of weeds reported by different authorities to be destroyed by sulphuric acid solutions of various strengths, varying from 3.5 to 10 per cent.

(6) *Caustic soda.*—A strong solution of this makes a cheap and effective herbicide, commended especially for pouring on soil where it is desired to destroy deep rooted or woody plants. Of course soil so treated will be rendered sterile for some time, but the soda will

gradually leach away. Like salt, this is most effective if applied in hot, dry weather.

(7) *Arsenical compounds.*—One or another of the soluble arsenical compounds form the most effective herbicides known. The simplest to employ is arsenate of soda. This needs only to be dissolved in water for use, at the rate of one pound in three to nine gallons of water.

A question of importance in the use of chemicals for weed eradication is the possibility of such compounds exerting a harmful effect on the soil with risk of injury to the subsequent crop. Some investigations on these lines have been carried out by Bowser and Newton both in the field and green house and under controlled conditions. The liability of damage depends in part at least on the rate of decomposition of the chemical, its rate of movement in the soil and its effect on microbiological activity. Sulphuric acid and copper sulphate which are employed chiefly as leaf-sprays showed no lethal effect on the soil and nitrification was not affected. Sodium chlorate on the other hand, which is mainly used for the eradication of hardy perennials, remained undecomposed for a considerable time—poisonous effects lasting nearly two years after application has been made.

Steam.—'Live' steam has been used extensively in some countries for killing weeds, but in almost all cases it has failed to meet the desired end. The failure was due to the fact that the steam only came in touch with the leaves and stalks which were split and discoloured by the steam, but it failed to reach the buried roots in the soil. The result was that new shoots appeared in a short time from the scalded plants. The use of steam for the destruction of weeds is limited for the following reasons:

(1) It is a very costly affair;
(2) When steam is turned into unploughed ground, it kills only the shoots of plants, while the roots remain alive;
(3) When the field is ploughed and cross-ploughed in order to expose the roots of the weeds to the action of steam, it is successful to a greater extent than when applied to the shoots. But in this case too, it fails to reach all the roots some of which lie concealed in the soil. And if one escapes death it invades the whole field again;

(4) When 'live' steam is passed into the soil, it kills all forms of life in the soil especially the nitrifying bacteria, hence there is the greatest danger of the soil becoming sterile;

(5) When steam is passed into the soil it lowers the humus content of the soil, and destroys a number of plant food substances; and

(6) Steam cannot be passed into a soil where a crop is standing.

From all these considerations it is quite evident that the use of steam for killing weeds is impracticable and entails a great expenditure with least outcome. Steam therefore cannot be profitably used for the eradication of weeds.

Mechanical Collection and Destruction

Practical experience shows that a better method of weed eradication in comparison with those that have been described above is the collection and destruction of the weed. To some the cost of labour for this purpose may at first sight appear prohibitive, but a thorough study will reveal the fact that this method is more efficient and economical in the end than the others described above. But it should be remembered that, in order to get the most satisfactory results, they should be collected at a definite time. For this as has been mentioned above a thorough study of the life history of the plant should be made, the different modes of its reproduction studied, and the plant attacked at the most vulnerable point in its life-cycle. The plants should be collected before flowering and seeding with all their roots. In this connection it is worthwhile to remember also that under all circumstances, weeding should be done on a sunny dry day, and when there is no possibility of rain for the following seven days at least. This gives the plants the least scope for regermination due to lack of moisture. The collected plants should be allowed to rot in a pit or composted with cowdung or other farm refuse and then applied to the field when well rotted. This method of destroying weeds has been found economical, practical and satisfactory by a large number of cultivators.

Control of Weeds

The control of weeds is more important than its eradication. The use of fungal or insect parasite, chemicals, 'live' steam and the mechanical collection and destruction of the weeds offer no specific cure all against them. Cultivation, rotations, and watchfulness against the introduction and scattering of weed seeds are all of more fundamental importance in combating weeds than chemicals, steam, fungal parasites and their mechanical collection and destruction. No doubt, in some special, but very rare cases chemicals, fungal parasites and steam have proved very successful, but one should not be blind to the fact that these methods adopted for the extermination of weeds are secondary rather than primary.

The measures taken to control weeds depend first of all upon whether the weed is an annual, a biennial, or a perennial. It is obviously one problem to deal with perennials and another problem to deal with annuals and biennials. In the annuals and biennials which are generally propagated by seeds it is necessary only to prevent seeding so far as dissemination or persistence is concerned. A single plant of many common weeds will produce hundreds or thousands of seeds. Moreover not all of these seeds will germinate the first year, and the seedlings may continue for several years. Harrowing and cultivating farm lands not only will improve soil conditions for the growing crop but will also destroy a countless number of weed-seedlings. Pasturing off the weeds with sheep, goats and cattle are efficient means of destroying weeds if practised before they come to bloom.

In the case of the perennials it is necessary to destroy or crowd out the entire plant, root and all. Perennials can thus be held in check by prevention of seeding, destruction of the top-growth and the killing of the structures beneath ground which store food. All these may be accomplished by mechanical means, such as the hoe, scythe, mower or cultivator. Destruction of the top growth may also be accomplished by chemical means, employing sprays, which may merely destroy the top growth or may also penetrate the roots or root-stocks.

The control of weeds is a major item in farm management and upon its proper management depends to a considerable extent the

outcome of the business. The subject of weed control has attracted the attention of all tillers of the soil at all times and in all regimes. But the results achieved have not been very promising and satisfactory. This has been mainly due to the fact that the principles of weed control have not been strictly followed by the cultivators. In any programme of weed control the following points should be very strictly adhered to:

(1) *Crop Rotation*:—In any serious programme of weed control crop rotation plays a leading part. Among the many well established reasons for such procedure control of weeds is one of the most important. Planting land to the same crop for a series of years in succession encourages weed growth, and a lack of proper rotation is a chief cause of weedy fields.

(2) *Clean cultivation*:—Though it aims primarily at starvation of roots or underground stems of perennials also continually keeps the soil stirred and brings seeds formerly produced by weeds to the soil surface where, under favourable conditions, they germinate, the seedlings being killed by subsequent cultivations. Thus clean cultivation serves to bring about a decrease in the number of weed seeds in the soil. If clean cultivation of a row crop is carried on for a year or two, perennials are very much weakened, if not killed out.

(3) *Smothering*:—Weeds may often be suppressed or much reduced by the growth of dense, heavy smother crops which choke them out. Suitable crops for the purpose are vetches, or a mixture of vetches, peas or beans.

(4) *Clean seed*:—Under no circumstances should imperfectly cleaned seed be either purchased or sown.

(5) *Clean manure*:—Under no circumstances should cattle manure or composts contaminated with weed seeds be applied to farm lands.

(6) Roadsides and other wastes where the weeds multiply and breed should always be kept clean.

(7) New weeds when they begin to invade the neighbourhood should be recognised promptly and necessary steps taken for its eradication.

(8) Care should always be taken to prevent the top growth of the weeds; they should not be allowed to form seeds and their underground roots or rootstocks should be starved to death.

Conclusion

Insects and plant diseases are the plagues of the husbandman. But no less are the weeds a plague to the tiller of the soil.

They rob the soil of water and food materials and do a number of other damages. The farmer should remember that all weedy fields are poorly managed fields. Nature covers all areas and Nature knows why. *But the farmer in dealing with the weeds should work* out such a system of crop management as will afford the weeds the least opportunity to gain a foot-hold. Efficient agriculture is an efficient management of weeds. And the dexterity and the skill of the husbandman is judged more by the cleanliness of the field than by any other one factor in farm management.—"*The Allahabad Farmer,*" *Vol. XV, No.* 1, *for January,* 1941.

VOLUME LXVII 283 NUMBER 6

INDIAN FORESTER

JUNE, 1941

SAL REGENERATION *DE NOVO*

BY R. N. DE, I.F.S.

A number of articles have appeared lately in the *Indian Forester,* the one last written being by Mr. Smythies in the April (1940) number in which he sums up the technique adopted and success attained in U.P. Type B_3 —"Moist High Level Alluvial Sal" of Champion. In a note on the above article, Mr. Hall states that the regeneration may take 15 to 20 years and the cost of shrub-cutting alone may be Rs. 30 per acre.*

Assam has been very early in the field to study the problem of sal regeneration and the late Mr. Milroy was first in revolting against the orthodox method of fire-protection of sal forests. He found that sal forests outside the reserves which were open to grazing and burning year after year had plenty of sal regeneration, but there was complete absence of it inside the reserves. Consequent on the abandonment of fire protection about the year 1916, forests of his Division, Kamrup, got burnt here and there as opportunity occurred, especially in places where openings had been made by fellings and grass, mainly *Imperata arundinacea,* began to come in. As the burn went on year after year, more of the evergreen became amenable to burning and more and more grass appeared inside the reserves.

In the cold weather of 1925, some officers from Bengal, headed by Mr. Shebbeare, the then Conservator of Forests, came to Kamrup to see sal regeneration. Milroy and I had showed them some small patches of seedlings here and there which had by then been burnt by the usual fire. The party were rather sceptical regarding the natural regeneration they saw. Fifteen years have elapsed since that visit and now seedlings of sal are so common in Kamrup that no one need look for them.

As remarked before, sal regeneration was found in plenty in the fire-burnt and grazed zemindari forests, but not in the fire-protected

* *Indian Forester,* April, 1940.

government reserves. Milroy's thought naturally turned towards changing the undergrowth to grass by burning. Hence he abandoned fire protection and introduced burning. He also laid out some plots inside the reserves for observing the progress of natural regeneration.

In the year 1933, when the delegates of the All-India "Sal Committee" visited Kamrup there was grass, chiefly *Imperata arundinacea,* almost everywhere and whippy seedlings of sal could be found where the grass was light. Mr. Champion who was then Central Silviculturist and toured with the party remarked: "After five seasons (of fellings under Bor's new Working Plan), a few coppice shoots are now visible above the grass, etc., and there are comparatively few whippy shoots two to four feet high and plenty of small new 1932 seedlings. There has thus been no discernible progress in the regeneration of these groups (group fellings as prescribed in the Plan) except the first mentioned and *on the records some retrogression appears probable since* 1930."*

In the cold weather of 1935, the Inspector-General of Forests (Sir Gerald Trevor) toured in Kamrup and Goalpara Divisions and noted that patches of sal were established in some of the compartments by the uprooting of the *Eupatorium* and rains-weeding in Kamrup. He also remarked that heavy fellings caused the grass to go out of hand in some of the compartments in Kamrup. In the Bhabar area of the Goalpara Division, he found hardly any regeneration in the undergrowth which was chiefly Sau (*Pollinia ciliata*), but here also by rains-weeding sal seedlings were established in four years.†

The position in Kamrup at the time of Sir Gerald's visit was that grass (*Imperata arundinacea*) was found almost everywhere as undergrowth due to opening up of the canopy and burning and *Eupatorium* had also made its appearance and was suppressing the grass in many compartments. Whippy sal regeneration was found in grass and under *Eupatorium,* but not established except in patches where rains-weeding and pulling out of the *Eupatorium* was done. It will thus be seen that burning alone was not enough. The "Sal Committee" remarked: "In the heavy thatch associated with full

* Regeneration and Management of Sal—Champion.
† *Indian Forester*, April, 1936.

overhead light over large areas, the rate of addition of new stocks was far too slow to be acceptable as part of a system of management."*

At present, there are several compartments in the Kamrup Division where patches of sal have been fully established or are being established by rains-weedings and pulling out of *Eupatorium*. It so happens, however, that most of the progress is due to these operations and not to early burning only which is practised as a routine measure in all forests. And the *established seedlings do not belong to the compartments which were kept under observation since Milroy's time.*

Four main factors need consideration in *de novo* sal regeneration:

(*i*) Weeding,
(*ii*) Canopy manipulation,
(*iii*) Burning and
(*iv*) Grazing.

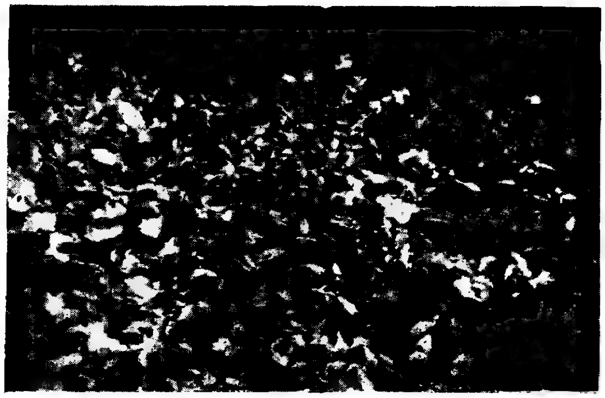
(*i*) *Weeding*—The crux of the problem lies in the timely rains-weeding of the sal seedlings. From the results obtained in my observation plots in Goalpara it is found that seedfall to established stage can be reached by weeding only in four years by keeping out fire which is detrimental to the growth of sal seedlings.† In my experiments covering a period of several years in Goalpara, I started with wholesale weeding of sal under mother trees and it cost about Rs. 45 per acre up to establishment. In order to minimise the cost, I took up another area and cleared two-foot wide lines through weeds, chiefly *Pollinia,* eight feet apart under sal mother trees in a good seed year and supplemented the seed dispersal by scattering seeds where no mother trees were found. Two weedings were done during the rains and excellent lines of sal came up at a much cheaper cost. But the experiment was unfortunately disturbed by allowing a fire to go through the area and thus the growth was put back by at least two years. The current Working Plan of the Bhabar Sal is based on this method. At the instance of Sir Gerald Trevor, a plot was cleared of the weed *Pollinia,* in order to see if any seedlings germinated and persisted at the end of one rainy sea-

* *Indian Forester,* September, 1936.
† *Indian Forester,* November, 1938.

son under Sau (*Pollinia ciliata*). The result was most encouraging as thousands of seedlings were found surviving under Sau (*Pollinia ciliata*), thus showing that one rains-weeding could be dispensed with in the first year. The seedlings were not, however, so tall and stout as those weeded in the first year. Whatever progress has been made in Kamrup is either in compartments where there was hardly any coarse grass due to grazing or where rains-weedings and *Eupatorium* pulling were done. Indeed these have been adopted as a routine measure in Kamrup Division despite early burning. Apart from grazing, the control of weeds (including *Imperata*) depends to a large extent on the admittance of light to the forest floor and this brings us to the next item, canopy manipulation.

(*ii*) *Canopy manipulation.*—In Kamrup, canopy was opened up to admit more light and facilitate burning and thus introduce thatch grass (*Imperata arundinacea*) which was then supposed to be a *sine qua non* of sal regeneration. My observation plots have definitely proved this not to be the case. Throughout the greater part of the forests except those under bamboos and *Eupatorium*, grass is the chief undergrowth. There are villages scattered throughout the forests and grazing has been permitted in all plain compartments throughout the year. Where the opening has been too big and grazing light, the grass has grown so thick that no regeneration can ever survive in it in any quantity, due to suppression and fire. Too much opening of the canopy to induce grass in a sal forest is not at all necessary, nay, it is detrimental to the natural regeneration of sal as weeds become more luxuriant. Although *Imperata arundinacea* of the short variety allows the sal seedlings to germinate and grow, this type is not found throughout the forest and grass is most troublesome and expensive to weed out. In my observation plot in Compartment 10, Barobadha (Goalpara), not a single tree either in the top or middle canopy was felled. Only small shrubs like *Morinda* and *Clerodendron* and weeds were cut and burnt before seedfall which was supplemented by broadcast sowing. Two rains-weedings were done every year and the area was fire-protected. As the seedlings began to grow bigger and bigger, more and more trees from the top canopy were removed (Plate 9, Fig. I). Sal regeneration is now established nearly everywhere in four years and the canopy is awaiting complete removal.

Fig. I



6-3-40. *Photo: R. N. De*

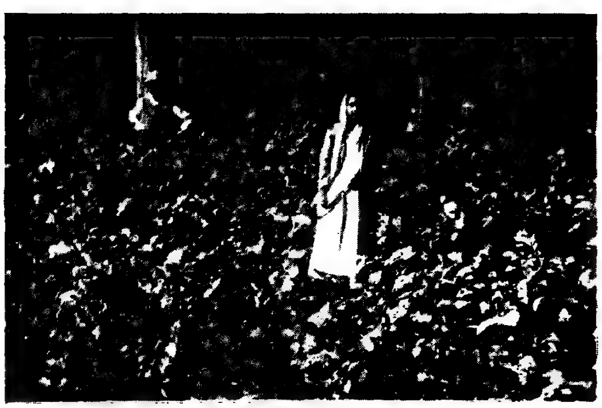
Natural regeneration of Sal, three rains old, under a Sal canopy, weeded twice during each rainy season. Barobadha, Guma Range.

Fig. II

15-2-40. *Photo: R. N. De*

Natural regeneration of Sal under canopy of unknown age brought up to establishment by rains weeding from 1938. Bamuni Reserve, Nowgong Division. Canopy now nearly removed.

Fig. III



21-11-40. *Photo: R. N. De*

Natural regeneration of Sal being raised by rains weeding from 1938 and fire protection under mother trees. Chardnar Reserve, Darrang Division.

Fig. IV

10-12-40. *Photo: R. N. De*

Natural regeneration of Sal getting established under bamboos without fire. Rongrenggiri Reserve, Garo Hills.

That canopy can be kept even altogether intact and yet it is possible to get the regeneration up by weeding alone has been shewn by Mr. C. S. Purkayastha in the Kolahat and Hojai Reserves of the Nowgong Division. He has induced sal regeneration over 10 acres having scattered sal and other trees, viz., *Lagerstroemia parviflora, Dillenia pentagyna, Careya arborea, Garuga pinnata, Odina Wodier,* etc. There the thatch has not invaded the plots and the cost of weeding is much less in consequence. In the same Division in the Diju and Bamuni Reserves, he has grown sal seedlings under the interrupted canopy of bamboos and trees and most of it is now established in four years (Plate 9, Fig. II). And it is remarkable that where big gaps like 50 to 60 feet across have been made and thatch has come in, the seedlings have not advanced so well. The ground cover in parts of the area is Kopat (*Phrynium*), an essentially evergreen plant, but the sal recruitment has not in any way been hindered thereby. In the Darrang Division also under a normal canopy, profuse sal regeneration is found all over the forest where the weed growth is kept in check (Plate 9, Fig. III). In Bihar also, sal regeneration is obtained under a fairly complete canopy.*

(*iii*) *Burning.*—In the above instances, regeneration has been established without burning in the Goalpara, Nowgong and Darrang Divisions in four to five years. Now the question is whether fire plays any part in the silviculture of sal regeneration. In my Stage I experiments in different localities of the Goalpara Division (now Kachugaon and Haltugaon Divisions), I had established natural regeneration by rains-weeding in open as well as close canopy in four years by fire protection† and the same thing is being done in the Nowgong and Darrang Divisions under an almost complete canopy. It is obvious then, that fire is not a silvicultural necessity in this type of forest for inducing sal regeneration, nor the introduction of grass a *sine qua non* of natural regeneration of sal. It is true that by repeated burning the evergreen undergrowth, where it occurs, is considerably weakened and often turned into grass, but there is no need for such transformation as the evergreen weeds can be quite efficiently dealt with by weeding. My experience of sal all these years is that burning alone cannot and

* *Indian Forester*, June, 1940.

† *Indian Forester*, November, 1938.

will not induce sal regeneration and help in the establishment of sal seedlings unless grass is kept in check either by canopy control, grazing and/or weeding. In the Kamrup Division where early burning is practised as a routine measure, it is in the moderately grazed areas and *Eupatorium*-uprooted plots only that most progress has been made. The effect of fire on grass in those localities is negligible owing to the fact that the grass kept in check by grazing and *Eupatorium* cannot produce a fire bad enough to scorch the seedlings. Fire and opening of the canopy undoubtedly induce the grass to grow, but rains-weeding is much easier in localities where the weed is other than grass and it is better to keep the canopy rather close initially so that the grass does not come in in quantities and create difficulties for subsequent weeding and fire protection. In the Garo Hills Division, a good deal of sal regeneration in different stages of establishment is found under bamboos which do not allow any weed to grow under their shade, but the sal regeneration which thus escapes fire and persists under bamboos at once shoots up as soon as the bamboos are removed (Plate 9, Fig. IV). Once the grass has come in, there is no alternative left than either to burn the grass early so as to avoid a fierce fire in hot season or to protect the forest against fire. Burning is an insurance against subsequent fire damage and it induces young grass to shoot up so that cattle may be induced to graze. It is true that a fairly complete canopy would not permit the seedlings to grow as well as in the open light, but one has to remember that once the openings are made and the forest is burnt, the grass has got to be kept under control and it is by no means an easy matter. Some people seem to think that burning is a very cheap operation. It is not so and here in Assam the cost of early large-scale burning varies from eight annas to one rupee eight annas per acre per year and sometimes even more and there is no advantage in having grass unless grazing is also introduced.

In the United Provinces, the undergrowth in sal forest is *Clerodendron, Mallotus* in dwarf form and other shrubs and the canopy is, as far as I remember, much closer than that of our sal forests and it may be necessary to burn the forest to induce "light" grass so as to have a 50/50 mixture of *Clerodendron* and grass

which is understood to be the ideal condition for natural regeneration. Mr. Smythies, whom I fortunately met at Cawnpore shortly before he retired and discussed the problem, told me that without burning shrubs do not lose their vigour. I am, therefore, curious to know whether grass which comes in with burning is of any advantage at all or whether it is only a concomittant evil that has to be put up with in course of reducing the vigour and incidence of shrubs and weeds. In Bihar burning is considered to be a disadvantage as it kills many recruitments and older seedlings of previous years and there is no doubt that it is true of all sal forests. Early burning to be successful has to be repeated twice or thrice and however mild the fire may be, there can be no question about the death of many seedlings by successive scorching.

(*iv*) *Grazing.*—The effect of grazing in sal forests of Assam has not been properly investigated, but our zemindari forests have been burnt and grazed for many years and natural regeneration is found in abundance there. The grass is chiefly *Imperata arundinacea* which is grazed by cattle throughout the year and kept under control. Fire passes through the forest during the cold weather, but the damage done is negligible owing to the fact that there is hardly anything to burn except the leaf layer and grass stubble. Many seedlings, therefore, escape fire and they are kept free from suppression of weeds which are eaten by cattle. If we want to reproduce these conditions in our reserve forests, they must be reproduced in their entirety. It is simply harmful to adopt one factor—burning—and reject the other. These must go together. There are places which are overgrazed, viz., localities near the villages where hardly any sal seedling is found and the soil is bereft of its top humus layer. Areas farthest from the villages are scarcely visited by cattle and there the grass is too coarse to permit any sal regeneration to make headway and early burning is also more expensive. Moiranuddee in Kamrup is an example in point. The ideal condition is found in areas neither too far, nor too near the villages. Here the grass is kept in check by moderate grazing and fire cannot do much damage. Such are the localities in the reserves of the Kamrup Division that had the most sal regeneration before any weeding and pulling out of the *Eupatorium* commenced in that

Division and the present-day progress is due chiefly to these latter operations and not burning.

Sal seedlings do better in the open, but it must be remembered that opening out of the canopy brings in grass which must be kept in check by grazing or the canopy should be kept fairly close initially. Then again grass introduces fire danger for which early burning, an operation not at all a necessity for the natural regeneration of sal, must be resorted to to minimise fire damage.

Finally, mention must be made of the rôle of *Eupatorium odoratum* in the natural regeneration of sal. Having light seeds provided with parachutes, it spreads far and wide in the grassy areas and openings and establishes itself quickly. The grass is swamped and killed but its lower branches being clean, sal seeds can reach the soil through its bushes. No weed can grow under *Eupatorium* shade but sal seedlings can persist for some time. When the *Eupatorium* is cut out, an amazing mat of sal seedlings is often found under the *Eupatorium* bushes. It has indeed been described as a blessing in disguise.* This is how a good deal of natural sal regeneration has been lately brought up in the Kamrup Division. There is not a single instance in the whole of the Division where a plot was started initially with no regeneration and the recruitment was brought into the establishment stage by burning only. Whatever regeneration was found in the past was chiefly due to grazing combined with burning and now weeding and pulling out of *Eupatorium* have contributed to the success of regeneration.

Since I wrote this note, I have read Mr. Rowntree's article, "Grazing *versus* Burning," in the November number of the *Indian Forester* and I add the following remarks: I entirely agree with Mr. Rowntree that prior to the adoption of rains weeding and *Eupatorium* pulling (which is nothing but a form of weeding), any regeneration that came up in the Kamrup Division must have been due to *grazing and burning* and not to burning only. Burning killed the evergreen which grew luxuriantly due to fire protection for years and encouraged the grass to grow which was grazed by cattle and kept low enough to permit the sal recruitment to get

* Kamrup Working Plan, 1929-30 to 1939-40, by Bor.

through. That burning is not a *sine qua non* of sal regeneration has been proved from my experimental plots in the Goalpara Division.*

As regards Batta (*Imperata arundinacea*) and Ullu, a short form of Batta, it may be interesting to note that although the Botanists consider them to be the same, two distinct species are locally recognised and it gets support from the fact that during my tour in that Division, Forest Ranger M. N. Pait dug out in my presence root systems of depauperised Batta and Ullu growing in intimate mixture and in every case they were found to possess separate root systems with no connection with each other. Some people seem to think that burning has a depauperising effect on grass. If this were correct, the thatch *mahals* of Sylhet would have been extinct by now, as burning has been practised for the last 50 years as a routine measure in every thatch area after it is cut, so that better thatch grows next year. Burning induces new grass to sprout which cattle like. If, therefore, it is desired to keep down the grass by grazing, burning has to be done in order to induce the cattle to graze.

To sum up:

(1) Rains-weeding is the first and most effective factor in sal regeneration.

(2) Burning is not a *sine qua non* of sal regeneration.

(3) Thatch (*Imperata arundinacea*) or any other grass is neither an indicator of sal soil nor is its introduction necessary for inducing sal regeneration.

(4) If it is desired to keep down the already existing thatch by grazing, burning is necessary to induce the cattle to graze on the new grass.

(5) Burning never depauperises the grass (*Imperata arundinacea*).

(6) Sal regeneration can be induced both with open and close canopy. In the latter case, the canopy must be gradually opened out to give the regeneration more and more light for eventual establishment.

* *Indian Forester*, November, 1938.

(7) Too much opening of the canopy induces weeds and grass through which sal recruitment, even if it is obtained, cannot make any headway and eventually perishes unless assisted by rains-weeding.

(8) *Eupatorium odoratum* is a nurse of sal in early stage.

THE INFLUENCE OF FORESTS ON CLIMATE

SAL REGENERATION *DE NOVO*

By W. D. M. Warren, I.F.S.

Summary.—The influence of forests on the local (micro) climate has been scientifically proved from ground meteorological data. Certain indisputable climatic Laws have been enunciated explaining why this happens. Deductions from upper air observations are liable to serious error, and cannot upset these facts. More research is required to prove how far the climatic influence extends beyond the forest edge.

Considerable interest appears to have been aroused by my note* last June on "Sal Regeneration *de novo*," both in its silvicultural and in its climatic aspects. I have already given my reply on the issue as it appears to affect the sal forests of the United Provinces, and will now reply to those critics who even question whether forests exert any influence on climate at all.

In the June note, I used the following words "Climatologists will tell you that it is quite possible to modify a forest climate by converting arid to luxuriantly growing forests." I also quoted in particular Dr. Visher of Indiana University, U.S.A.: "There is no doubt as to the decided effect upon soil moisture of contour trenching. This increase in rainfall absorption greatly stimulates plant growth and this, in turn, alters the climate of the immediate locality (in the forest and close vicinity)." I have since, in my reply to Mr. Raynor, quoted Dr. Normand, Head of the Meteorological Department of India as saying: "Increase your soil moisture and you automatically improve your climate." In the August issue,* "Junius Junior" challeged the views of the June issue and quoted as his authority Mr. Thornthwaite of the Soil Conservation Service, United States. He has also been supported by "Another Junius Senior" in the January 1941 issue,* in spite of the fact that the summary of a whole chapter of Toumey and Korstian's Text-Book on

---

* *Indian Forester.*

the influence of forests on climate has been quoted against him by "Another Junius Junior." It will thus be seen that Mr. Thornthwaite and his supporters have eminent Climatologists as well as text-book evidence ranged against them.

It is true, of course, as "Another Junius Senior" pointed out, that the summary of Toumey and Korstian's chapter was not a direct reply to Mr. Thornthwaite's deductions. I had hoped to get an authoritative reply direct from the Meteorological Department at Poona but apparently they are too busy with war work.

To view matters in their right perspective it should be pointed out that Mr. Thornthwaite is perhaps not a Climatologist at all. At least he signs himself as being a member of the Soil Conservation Service of America, whose duty it is to be expert on soil erosion problems. Consequently one should receive his deductions on meteorological data with reserve until they have been accepted by acknowledged Climatologists. Mr. Thornthwaite apparently obtained certain figures of temperature, pressure and humidity of the upper air, kept over a period of five years, from the Weather Bureau, and made certain deductions. The chief weakness, in my opinion, lies in assuming that the meteorological conditions of the upper air are a true reflection of what is happening 5,000 or more feet below (meteorological readings of the upper air, are taken from 5,000 feet upwards). Such readings are never meant to be used for such a purpose. They are primarily intended to help the meteorologist to predict his weather forecasts, as changes in meteorological conditions are first reflected changes in the upper air currents.

Here are examples where deductions from upper air readings might prove erroneous. Forests are known to cool down the temperatures and to raise relative humidities. Now cooler air always sinks into the valleys and so the instruments 5,000 or more feet up would fail to record such movements. Furthermore, humid air as well as hot air rises but, in doing so, expands, thereby diffusing the humid effect. Moreover, winds can blow horizontally thereby again spreading the modifying effects of forests sideways, and not upwards, to the confusion of the upper air recordings. Similarly, high level hot air could blow along horizontally which

might have no effect upon the cooler layers beneath beyond dispersing gathered clouds, thus making confusion worse confounded.

Because of these extraneous factors, it would be very difficult to get upper atmospheres in different localities, which were comparable except for the presence or absence of forests down below. Consequently, to my mind, the only way to ensure that deductions from the upper air readings correctly reflected the influence of different ground covers on the local climate would be for those readings to be taken for a sufficient number of years to produce a normal for each locality before changing the ground cover by, say, afforestation, and then to watch the effect of such changes on the readings. Mr. Thornthwaite appears to have lacked such data.

But why place so much importance on upper air readings? At their best they can only supplement—not replace—ground meteorological observations, and if these latter indicate that forests do bring about certain climatic improvements, one must accept them as facts as long as they have been scientifically proved.

In talks and in correspondence with Climatologists, I was impressed by the fact that all, without exception, admit the modifying effect of forests on climate. Statements which the average forest officer, in his ignorance, would challenge, are accepted by them as *fundamentals. It is not among* Climatologists that the fierce controversies on climatic behaviour apparently arise, but mostly in our profession *through our imperfect knowledge.*

At Oxford in 1939 it was not Mr. Kendrew of the Geographical Department (who is interested in Bio-Climatology) who attacked me—in fact all his suggestions were helpful and friendly but a forest officer on leave who was interested in my tentative deductions. The latter was a veritable tiger!! Climatologists have given us every encouragement to pursue our climatic researches. Oxford have even offered to analyse and work up for us any climatic data we may care to send in.

Mr. Thornthwaite's deduction, that "continental evaporation as a source of local precipitation is negligible," would probably be challenged by all climatologists. Murray's estimate (Visher) that of all rainfall in America, on the average 75 per cent. comes from evaporation from the land and only 25 per cent. from the sea, may possibly not be quite correct; it is only an estimate, but there can

be little doubt that land evaporation and forest transpiration are important sources of atmospheric moisture for condensation in the form of rain. Thus we read: "winds laden with moisture may sweep over such arid regions as the Desert of Sahara, the Arabian Desert and the Thar (Sindh) Desert without having their moisture condensed. In fact the hot, sandy soil produces the opposite effect and renders the air capable of taking up more moisture."

Mr. Thornthwaite's second deduction is that "changes in vegetation or land use, although not denying an influense on evaporation, will not increase or decrease local precipitation by any measurable amount." This deduction comes into direct conflict with the evidence of climatic influence exerted by forests, which occupies a whole chapter of Toumey and Korstian's Text-book.

However, let us ask ourselves why forests influence and modify the local climate. It is so much more satisfactory to understand not only that forests do influence the climate but why they do:

(1) Firstly, they effect the temperature of the locality, the air being cooler by day as the leaves reflect much radiant heat from their shiny leaves and absorb much. The air is warmer at night because the leaves interfere bodily with the escape of heat from below, compared with open places. [Actually the Bamiaburu contour trenching has reduced both the night and the day temperatures.]

(2) Transpiration also has a cooling effect. Dense tropical forests have much greater evaporating surfaces in their leaves than does the sea at coastal stations.

The effect of the cooler temperatures is to reduce the capacity of the local atmosphere for holding moisture and so clouds are more quickly condensed.

(3) Dense vegetation also maintains a layer of still air between the atmosphere and the land and this hinders the conduction of heat between them.

(4) Transpiration increases the relative humidity of the locality, bringing it nearer the precipitation point, thus helping the lowered temperatures to reach the

precipitation point more quickly. We have a very good example in this Province. In a hot, dry summer the comparatively treeless Ranchi Plateau drops to a humidity of 10 or even 5, with an average of 25 to 30 for the month (April usually) whereas, in close proximity to the Singhbhum forests, Chaibassa's humidity rarely drops below 50 and averages 58.

(5) Variability in the amount of rainfall increases in arid regions because among other things the abundant soil moisture, the dense vegetation and the greater standing water present in humid regions all help to stabilise atmospheric moisture conditions. Seasonal changes come more quickly in arid than in humid regions, because there are fewer clouds and less atmospheric moisture to hinder radiation.

(6) Diurnal range of temperature also increases on the average with aridity.

(7) In moist regions the increased evaporation or transpiration when day temperatures begin to soar prevents the temperatures rising much more than 100°F.

Already many of the above climatic laws have been proved true at Bamiaburu, where dry, open forests have been converted to the more luxuriant damper and denser types. [It might be added that climatologists are not yet convinced that this modification of local climate extends much beyond the limits of the forest area. Chiefly, I think, because no one has ever proved it, although it is arguable that the influence must extend for a considerable distance especially where the forest tract is a big one.]

Forest areas can have cyclonic influence. Here is one more interesting fact about Bamiaburu. Readers will remember, three or four years ago, the question was asked how it came about that, in the hot weather, under disturbed meteorological conditions, awe-inspiring, big, fleecy cumuli clouds should come up evening after evening to condense and precipitate their moisture. No one could answer that question. The following year Mr. Owden and I saw small clouds approaching Bamiaburu from three different directions at the same time!! Again, on another occasion, hot weather clouds from the south gave only a drizzle but, five minutes later, on

looking to the north, it was noticed with astonishment that a black cloud had suddenly appeared and, after a preliminary streak of lightning, burst on us, giving a down-pour of .6 inches! The explanation of these phenomena now stands revealed in the text-book under the heading "Cyclones." It says: "Suppose a part of the earth to be heated more than another or *more saturated with water vapour,* such areas become regions of low air pressure, with a corresponding increase in pressure in the surround, with winds consequently blowing from the several directions, inwards, towards the centre of the low pressure area. This system is called a 'cyclone' (the word CYCLONE is often used in its more limited sense as meaning 'whirlwind') and it may cover a region from 100 miles to 3,000 miles across; a common diameter for a cyclonic system being 1,000 miles" So the Singhbhum forests which are nearly 100 miles across and much more if the Keonjhar forests are included, in the hot weather, when evaporation is intense, perhaps from a small cyclonic area through the transpiration of its trees, and Bamiaburu may be one of its focal points. [I write "in the hot weather" because then the contrast between the humidity of the forest and the paucity of it outside is greatest.] The thought is intriguing and is, to me, perhaps the most fascinating of all the climatic laws I have unearthed. It certainly does afford a satisfactory explanation of the observed meteorological phenomena which had been so puzzling.

We read that "in Great Britain the influence of cyclones tends to a more equal and general distribution of rain; and even the leeward sides of mountains receive plentiful moisture." Thus if each large forest belt in India either acts now, or can be made to function by contour trenching as a mild cyclonic area, it would, in the same way, tend to bring about a more equal distribution of rain.

Atmospheric Moisture not a fixed Quality.—"Another Junius Senior" raises an interesting point when he suggests that our contour trenching activities by precipitating every wandering cloud in May and early June are depriving the U.P. of much needed moisture for sal regeneration. His argument, based on the assumption that there is only a limited supply of atmospheric moisture available, and that if one locality precipitates it, another goes short, is a fallacy. The more runoff water each locality can hold up, the more will there be available locally—for conversion by evaporation

or transpiration into atmospheric moisture—for further precipitation. The same moisture *plus* extra from the outside, *minus* the amount which runs off, is available for precipitation evaporation and re-precipitation many times in the course of a single monsoon, so that the more one starts with at the beginning and the more efficient the holding up of the runoff, the more rainfall will one get before the season is through. However, all of this moisture does not evaporate and condense on the same spot. In between showers, when barometric pressures have smoothed out, the south-east winds, indrafts from the Bay of Bengal, blowing over the wetted and cooled surfaces of the Singhbhum forest, would pick up transpiration and evaporation moistures, to carry along to the United Provinces. This would go on continually throughout the premonsoon and monsoon period.

Similarly in the cold weather, when the north-east trade winds operate, moisture from Singhbhum would be carried towards Madras to strengthen the north-east monsoon there. In fact, instead of the U.P. claiming damages from Bihar at the bar of the Government of India, Bihar might, from the opposite point of view—with more reason—demand money from both the U.P. and Madras for benefits conferred! !

The United Provinces could makė out a much better case if it sued Bihar for permitting the Ranchi Plateau to become almost denuded of forest, thereby robbing the earlier south-east indraft winds of some of their moisture. I understand that 2,000 square miles of forest, equal in total area to the whole of the reserved and protected forests of Bihar, out of 7,000 on the Plateau, disappeared between the 1903 and the 1933 settlements. One can imagine the U.P. Foresters swearing hard under their breath at this news as they think of their sal regeneration difficulties! !

Let me emphasise that this argument—that what we do to our climate in Bihar, whether we desiccate it by deforestation or humidify it by improving the forest growth—has an effect on the climate of the United Provinces or Madras, is mere speculation. The argument is only used in order to refute "Another Junius Senior's" conclusion that we were robbing the U.P. of moisture. It goes far beyond what Climatologists admit has been proved.

It is possible that neither Bihar nor the U.P. now possess more than one-third to one-half of the forests it possessed one hundred years ago. In addition, certain forest areas of the U.P. have retrogressed to a drier state. Consequently, if the former moister, cooler climate is to be recaptured, our remaining forests must be made at least three times as luxuriant for giving shade and three times as efficient at producing moisture by transpiration as formerly. That can be done most quickly by refusing to allow water to run to waste off our hillsides in order that the local vegetation shall fully benefit. Present indications are that Bihar hill forests can be improved 71 times economically but I do not know how many times more luxuriant the forests become in the process!! That is a more difficult calculation!! However, it must be more than three times!!

The last remarks of "Another Junius Senior" are unworthy of him. The lie is given to his insinuation that "our rain-guages are designed specially only to record the increase in rainfall." In my report to the Silvicultural Conference, 1939, I discussed with the utmost frankness and honesty the good years and the bad—all the data in fact that was then available. It would be a sorry day for Research if Truth were dragged in the mud to serve an individual's bid for publicity. A *nom de plume* should not be used for such a base, unwarranted attack.

Faith we have admittedly, but it is a faith resting solidly on scientifically proved facts, which our own experiments support, and with the full support and approval of climatologists. That faith, too, is already moving mountains—mountains of prejudice born of ignorance—that have been arrayed against us!! However, perhaps in future, my critics will be better prepared to take these new ideas at their face value. Truth is often stronger than fiction!!

Summary.—To sum up, there can be absolutely no doubt that forests modify the local micro-climate to a considerable degree by reducing temperatures, raising humidities and making conditions more favourable for obtaining increased rainfall. Climatic laws explain why this should happen, and ground meteorological data confirm these views—*vide* Toumey and Korstian. The more luxuriant the forests, the greater is the micro-climatic benefit conferred. If

arid forests are converted to luxuriant forests, the climatic modification is also automatically increased. Climatologists are most definite about this, and our own climatic data at Bamiaburu and its neighbourhood, although not yet conclusive, show pointers in the same direction. Where climatologists counsel caution is in advertising the benefits conferred beyond the edge of the forests until those benefits have been proved.

Let us, then, as Forest Officers, in this knowledge, cease to argue over the fundamentals of forest influences on climate. To my mind it is so much waste of time as well as being discouraging to the Research worker. Instead, therefore, let us elevate climatic research to the status of a serious study rather than permit it to remain the butt for ridicule. We should concentrate on proving how far climatic modification due to the presence of forests extends beyond the forest edge. Hitherto most Research on micro-climates has been done in the Temperate Zones, in Europe and America, but, in my opinion, the Tropics hold out much more fruitful fields. In India we have a greater diversity of climate, from the extremely moist coastal climate to the extremely arid and continental. Moreover, our rainfalls, which, near the coast, can be extremely heavy, are seasonal, with comparatively little falling outside the south-west or the north-east monsoons, giving big annual ranges of temperature and big fluctuations in relative humidity. A locality can be extremely moist in the monsoon and extremely dry in the hot weather. Then, again, some of our forest tracts are among the most extensive in the world with—given the necessary amount of moisture—the most favourable conditions for growth. The transpiration air currents, under such conditions, would thus have the greatest effect on climate. Consequently, we should be able to prove climatic change in India much more quickly than elsewhere.

Already the Punjab and Bombay are following Bihar's example in utilising contour-trenching as an aid for improving growth. Other Provinces may follow suit. There is the possibility that if done on a sufficiently large scale, measurable climatic changes will result locally. It would be a pity not to watch local recording stations for such changes to find out how far from the forest such changes extend. If changes can be proved, we shall have one more argument with which to convince local governments of the necessity

for safeguarding and extending the areas under forest in order to safeguard and improve the local climate for the benefit of the agriculturist—the back-bone of Indian prosperity.

Now that the influence of forests on local climate is shown to be indisputable, the Forest Research Institute might itself encourage this line of Research. Not only would the Researches be of the utmost benefit to ourselves, but our results might be of use to our contemporaries in Africa and Western Australia where the desiccation of climate causes so much anxiety. It will be recalled that the 1935 Empire Forest Conference, presided over by our own Inspector-General of Forests, was especially asked to pronounce authoritatively on the value of forests for modifying climate. Their verdict was hampered by the lack of precise knowledge of the distance to which the climatic influence extends beyond the forest edge. It is time we set out to dispel that ignorance.

BIBLIOGRAPHY

(1) "An Advanced Practical Physical Geography," by MARROW AND LAMBERT.

(2) "Climatic Laws," by VISHER (Wiley & Sons, Inc., U.S.A.).

(3) The Effect of Contour-Trenching, Dry Hill Sal Forests on Climate and Growth, Silvicultural Conference, 1939, by W. D. M. WARREN.

(4) "Foundations of Silviculture," by TOUMEY AND KORSTIAN.

REVIEWS AND ABSTRACTS

COLONIAL FOREST ADMINISTRATION

BY R. S. TROUP.

Oxford University Press, 1940. *Price Rs.* 35.

Many forest officers of the Empire owe their forest training in part or wholly to the late Professor Troup. He is remembered as a sound, clear, and kind lecturer and adviser. This monumental work of compilation of information which, as is explained in the preface, has grown out of Professor Troup's lectures to probationers of the Colonial Forest Service, will have a wide appeal to many.

It is divided into two parts, the first of which is designated "General Principles" and consists of 317 pages covering the enormous field of general forestry. In the second part, of 108 pages, the forest policy, administration and progress of the various parts of the colonial empire are described serially. The book is well concluded with a series of valuable appendices on such subjects as Forests and Water Supply, the Possibilities of Forestry helping in the Control of the Tsetse Fly, Forest Legislation and Action in different Centres, Colonial Mining Laws and Timber Rights and Colonial Laws dealing with Forestry.

As has been mentioned, Part I covers a very wide field and includes chapters on Utility of Forests, Products of the Forest, Indirect Utility and Influence of Forests, Effects of Forest Destruction, Measures of Protection and Conservation, Character and Distribution of Forests, Forest Reservation, Forest Protection, Forest Organisation, Formation, Regeneration and Tending of Forest Crops, Production and Consumption of Wood, Forest Exploitation, Forest Ownership: State Control and Assistance, Forestry and Agriculture, Forestry and Mining, Forest Finance, Forest Legislation, Forest Administration, Forest Education, Research and other Activities and Enunciation of Forest Policy.

The book is intended to meet the needs of forest probationers, officers of the Forest Services and colonial administrators and should ably serve its purpose. It contains a wealth of information well and clearly presented, and it is of great interest to note how, throughout the book, Professor Troup's vast experience and knowledge of the

Indian Forest Service and of forest conditions in the Indian Empire has formed a background which enables the forest problems of the younger parts of the Empire to be understood. They can, if they will, benefit greatly from the experience of success and failure in India.

The book is an exceedingly valuable work of reference, well published by The Oxford University Press and contains a number of fine photographs, many of which were taken by the author himself. Such a publication could not help, however, being somewhat expensive.

Professor Troup has presented his information in a logical and clear manner and the reader's only regret will possibly be that the author has to such a large extent refrained from expressing personal opinions particularly of the more outspoken type.

It is impossible in a short notice to deal with such a vast subject-matter but mention must be made of such an excellent exposition of the indirect utility of forests, of the importance of which it is often very difficult to convince administrators whose primary object is generally to produce a balanced budget.

The book should prove an admirable help to many of us, who have to struggle to make vast peoples "forest-conscious," often being continually opposed by vested interests and consequent obstruction.

Unfortunately, Professor Troup did not live to see this last work an accomplished fact, but the greatest credit is due to those who saw the book through the Press.

Professor Troup has left us a number of publications but this last work is one of his greatest and should be a tower of strength to those responsible for the forest administration of the many and far-flung parts of the Empire.

A. L. G.

EXTRACTS

FOOD AND WOOD.

The view that neither agriculture, nor forestry, nor horticulture had *gained its proper place in the national regard was expressed by* SIR JOHN SUTHERLAND, C.B.E., LL.D., in his Presidential Address to the Edinburgh University Forestry Society, given in the Department of Forestry, 10 George Square, SIR JOHN described the soil as our greatest natural asset, and made a plea for a new policy to make the fullest and wisest use of our land.

SIR JOHN SUTHERLAND began his address by stressing the position of forestry in relation to agriculture, and specially in the light of experience over the last quarter of a century. Owing to the present war, which had been thrust upon us by a brutal and ruthless race, he said, the Government had been impelled to urge the farmer to grow more food, and the forester to cut down mature and immature timber crops in large quantities. Those who lived through the former attempt at aggression by the Germans would recollect that the action of the Government then was exactly the same—a rush to break up land for additional food, and as well to cut down timber.

There was one notable difference as between these two periods in our favour. In the former War some time elapsed before cultivation was ordered, and before timber felling commenced. This time the farmer and the forester were given marching orders immediately war was declared. Another favourable factor was the widely extended use of mechanised implements and vehicles. We could do much more with them in speeding up production in both industries.

As a sequel to the inroad upon our woodlands we attained a State Forest Service for the first time, and this Service had prosecuted a programme of planting which had established a quite considerable area of young woodland for use in the future.

HOME TIMBER TRADE

During the post-War period the owners of woodland had shared in the misfortunes of agriculture. They failed to find a market for their trees at remunerative prices, because imported timber was,

immediately after the War, thrown upon our shores in vast quantities at low cost. The home timber trade year by year decreased in production until, at the outbreak of the present war, the number of operating mills and the number of men engaged in this one-time flourshing industry was the lowest recorded since the last War.

He had always been convinced that it should be possible for agriculture and forestry to live together in harmony, and the effort in state forestry was to advance in this belief. All the same, the planting of trees had been opposed by the owners and occupiers of hill grazings, just at a time when these same people were representing to the authorities that the rearing of sheep was no longer a source of profit. The situation, it seemed to him, called for a comprehensive study of all questions relating to the utilization of land as a whole.

Some questions naturally arose as a result of the experience of latter years. For example, why should the raising of stocks and crops bear so much misfortune in times of peace when our consumption of all kinds of food far exceeded our capacity to produce, even if all our land capable of bearing crops were in full cultivation? Why, when an emergency came, had extreme steps at great expense to be introduced to provide our food or our wood? The answers seemed to be: (1) We had so accustomed ourselves as a nation to buy from overseas every commodity we required, without any due consideration of the implications involved; (2) neither agriculture nor forestry nor horticulture had gained its proper place in the national regard.

OUR GREATEST NATURAL ASSET

The soil, SIR JOHN contined, was our greatest natural asset. It remained with us always available and ready to yield its fruits, and it seemed criminal to neglect the fullest use of it. A new agricultural policy, built upon a permanent basis, was clearly required, and it must be sufficient to establish confidence in all branches of the industry. He did not forget that timber was an essential product—and all the more essential as a result of the present position in the Baltic and elsewhere, but there was no reason why forests should not be established without conflict with agriculture. Of necessity, timber crops took many years to mature, and afforestation

had become primarily an undertaking of the State, but means must be devised to continue the creation of woods by landowners, to whom, up to the present, we were indebted for the existence of mature woods to-day.

All experience seemed to point to the prudence of being always prepared in times of peace for the advent of war. It might mean sacrifice and subsidy and quite exceptional measures, but we should determine for the future always to keep the land in full bearing. Through this course, the vigour and strength of the nation would be preserved, and life in the country—the best life of all—would re-create a stable rural population capable of physical endurance far exceeding that of the industrial communities in the towns.

The time had surely come when a new policy should emerge—free from prejudice, and even tradition, and the initial step must be to determine by a census how the land surface of Britain was to be most wisely utilized—how much for agriculture, how much for forestry, and how much for horticulture, and other produce.—*The Scotsman,* dated 18th February, 1941.

INDIAN FORESTER

JULY, 1941

SAL REGENERATION *DE NOVO*

A Rejoinder

BY M. C. JACOB, I.F.S.

The following comments appear necessary as regards the article "Sal Regeneration *de novo*," by Mr. R. N. De, I.F.S.:

In the second paragraph of his article, Mr. De writes: "Consequent on the abandonment of fire-protection about the year 1916, forests of his (Milroy's) Division, Kamrup, got burnt here and there as opportunity occurred, specially in places where openings had been made by fellings and grass, mainly *Imperata arundinacea*, began to come in." This sentence shows a lamentable ignorance of the state of affairs at the time.

The following quotation from the Progress Report of Forest Administration for the Province of Assam for the year 1915-16 will prove that in Kamrup, at least, there was no question of the forest "*getting burnt*" but that every effort was made to burn the forests and that the efforts were crowned with complete success.

"In accordance with the principles laid down in the Inspector-General of Forests' note on the *sal* forests, protection from fire was abandoned in all the Divisions containing *sal* and evergreen forests and in almost all the *sal* forests every effort was made to burn them as completely as possible."

After referring to the difficulty of getting a burn in the low-level forests the report goes on to say that "in the drier forests of the Garo Hills, 80 per cent. was burnt, while in Kamrup when practically all the *sal* is of the high level and hill type the whole was successfully burnt."

As regards the tour of the so-called All-India "Sal Committee" in 1933 and the remarks of the Central Silviculturist quoted by Mr. De, the author, who had the privilege of tackling the problem of natural regeneration of *sal* in Kamrup in 1934 immediately after the said Committee's departure, can categorically state that neither

the group fellings nor their subsequent treatment were in accordance with the prescriptions of Dr. Bor's plan. They differed materially from his prescriptions especially in the following important respects:

Bor prescribed as follows, *vide* paragraph 180 of his plan: "To start with, the diameter of a group may be equal to the tree height. The groups will be enlarged in accordance with their silvicultural needs or in anticipation of a bumper seed year."

While the groups initially selected may have been of these dimensions, their enlargement was certainly not accomplished in accordance with their silvicultural needs but in accordance with revenue requirements.

Then in paragraph 179 Bor prescribed that "groups may be started in such places where seedlings are already on the ground or in areas where the undergrowth is favourable, *e.g.*, thatch, *Coffeya*, *Clerodendron*, etc. . . ."

The author's detailed inspection of the groups revealed that groups had been started even in such areas as were occupied by *Alpinia* and cane.

Again in paragraph 179, Bor prescribed that "no trees should be left standing in a group" and in paragraph 225 he specifically prescribed their removal. The author's inspection revealed that numerous trees, both *sal* and *kukat*, had been left standing in the groups. What had actually been done was to dispose of the saleable trees and no attempt had been made to fell the others. The excuse probably was their being of no sale value and paucity of funds for doing the work. The responsibility for this state of affairs was partly at least on those of certain officers who were loudest in their condemnation of Bor's plan to the so-called "All-India Sal Committee."

Then again in paragraph 234, it is prescribed as follows: "Maps will be prepared for each range, and posted up prominently in the Range Office, showing which areas are to be early burnt and which are to be burnt late. In thatch areas early burning is the rule while in evergreen areas late burning is essential." The utter lack of scrutiny of the maps is displayed by the fact that, in 1934, the author discovered that an entire compartment which had pure *Imperata* ground cover was shown as areas to be late burnt. The

Conservator had to take appropriate action against the officer who perpetrated this atrocity."

The above examples will suffice to prove that Bor's prescriptions were never given a chance partly at least by the complainants to the Sal Committee and to the Inspector-General of Forests, Mr. A. D. Blascheck.

As regards the Goalpara Division, the Division where Mr. De did his experiments, Bor wrote as follows in Paragraph 236 of his plan: "When the canopy is slightly opened the most favourable thatch of all is obtained; this is a variety which does not grow so vigorously as that of the open plains and it is this delicate variety which is best suited to *sal* in its early years." This gentle canopy opening was to be achieved by removal roughly of a quarter of the existing growing stock in the first ten years. Not wanting to tie the hands of the Divisional Forest Officer he did not prescribe any sequence. As regards *kukat* felling which was indulged in on a vast scale, the only justification that the perpetrators of this had was a sentence at Paragraph 312 as follows: "Evergreens must be felled over at least 640 acres in each felling series annually." It should be noted that the word "evergreen" was used and not deciduous species and, combined with Bor's prescriptions for gentle canopy opening referred to above, it cannot be stated that Bor's prescriptions were properly carried out when enormous areas in P.B.I. were made devoid of canopy control. As regards yield from P.B.I. at the end of this decade it was found when Mr. Stracey, the present Divisional Forest Officer, took over charge from Mr. De, that very nearly one year's yield had been removed in excess from P.B.I. during Mr. De's term while he was busy conducting his experiments, further helping in lack of canopy control.

In Parapragh 281, item (*c*), Bor prescribed as follows: "If labour is available, as much hoeing and working of the soil as possible in the neighbourhood of large seed trees must be carried out." There is no question that the labour was available, but little or nothing was done in this regard while large quantities of labour were being expended in afforestation work in grassland by the author of the article referred to.

The above remarks have been made only with the intention of clarifying the issue that if regeneration did not result it was not

solely due to faulty prescription, a chief point of which was burning and *canopy control* but due, to a great degree, to faulty execution or omission to execute on the part of the territorial officers, among whom must be included the author of the article referred to.

Discussing the position in Kamrup at the time of Sir Gerald Trevor's visit, Mr. De remarks that "whippy *sal* regeneration was found in grass and under *Eupatorium*, but not established except in patches where rains weeding and pulling out of *Eupatorium* was done." The statement would have been correct if the clause "where rains tending and pulling out of *Eupatorium* was done" had been omitted.

The author was in charge of Kamrup at the time of Sir Gerald's visit and he can state categorically that not only in rains weeded areas were there patches established but that there were established patches in areas such as the Satargaon area in Rani Range, Uttar Sandubi Compartment in Loharghat Range, Dakhin Nampathar Compartment in Singra Range, etc., where no rains weeding had been done.

The *Sal* Committee, which laid so much stress on ring-counting, later on discredited by the Wood Technologist as a correct criterion, would have been astonished to find that ring-counts of many of these established ones showed only six or seven rings. Even supposing that Sir Gerald did not find established seedlings, it does not warrant Mr. De's conclusion that burning alone was not enough, because the plan had been in operation only for five years and the regeneration period was 20 years. The *Sal* Committee remarked that "in heavy thatch associated with full overhead light over large areas, the rate of addition of new stocks was far too slow to be acceptable as part of a system of management." This remark of the *Sal* Committee was probably unnecessary as Bor's plan had not propounded any such theory. As "obiter dicta" such remarks are acceptable, but the implication that it ever formed part of a system of management was absolutely without foundation, *vide* Bor's restriction of the sizes of groups and strips.

As regards Mr. De's remark that by rains weeding and pulling out of *Eupatorium* patches of *sal* have been fully established or are being established, the author must make it clear that the rains

weeding done in Kamrup is *entirely different* from what was practised by Mr. De in Goalpara. Not a single blade of thatch was or is being cut in the rains weeding in Kamrup—a term the author has purposely avoided in the Kamrup plan—while in Goalpara, under the regime of Mr. De, thatch was also being weeded out. It is hoped that Mr. De's omission to mention that at least the great majority if not all these patches are being established in thatch is not on purpose. Because Mr. De finds reproduction more advanced in compartments where rains tending, involving *leaving of thatch*, has been done than in compartments where no weeding is done, therefore Mr. De jumps to the conclusion that weeding is the crux of the problem.

May I suggest that this may be due to the fact that proper canopy openings have not been effected in these and that such meticulous attention is not paid to timely burning in these compartments as in P.Bs. I and II compartments which alone are tended. I do not for a moment pretend that weeding does not help or that tending does not help but I am not prepared to jump to the conclusion as Mr. De has done that the crux of the problem is timely rains weeding. Mr. De has proved that *sal* seedlings can be established in four years from seedfall by keeping out fire. Many others have raised *sal* plantations before Mr. De came into the arena and the only difference between Mr. De's achievement and those of his predecessors who raised plantations is that Mr. De did not wound the soil while others did. Since soil hardness had never been claimed by any of the people who have done *sal* work in Assam to be the vital factor preventing regeneration, I hope Mr. De does not expect anybody to treat his achievement as a miracle.

As regards Mr. De's claim that the author's current Working Plan for Bhabar *sal* in Kochugaon Division is based on his method, a perusal of Paragraph 38 of Part II of that Plan will reveal that the author has no hatred either for thatch or fire provided it is controlled and the author has purposely avoided resorting to Mr. De's method of weeding out the thatch. The only similarity between the two methods is the pulling out of *Pollinia ciliata* initially. This idea also originated with the experimental pulling out of *Pollinia* from *sau* areas in Sajjanpara in Kamrup as early as about

1929 prior to the author's having charge of that Division when it was found that the areas were occupied rapidly by thatch.

Therefore, the author regrets that the evolution of this method also which did not find favour originally in Kamrup owing to its cost, unfortunately so far as the author of the current Kochugaon Plan is concerned, is not traceable to Mr. De's experiments in Kochugaon Division.

As regards Mr. De's remarks under canopy manipulation, nobody within recent years has supposed that the introduction of thatch grass (*Imperata arundinaceae*) is the *sine qua non* of *sal* regeneration. It is not the first time that Mr. De has made this statement which has been repeatedly denied by the protagonists of controlled burning. All that they have claimed is that thatch of the light variety is the undergrowth least objected to by *sal* seedlings in their progress towards establishment without weeding in their natural state and that its presence indicates the correct canopy opening for their progress towards establishment.

Mr. De's achievement of inducing regeneration under a close canopy and then getting the reproduction established by gradual removal of the canopy cover and by repeated weeding does not in any way disprove that contention. As a matter of fact, as Mr. De opened the canopy gradually thatch came in larger and larger quantities which he cut out. All that the protagonists of the controlled burning and thatch theory claimed and even now do claim is that light thatch does indicate a correct canopy opening for progress of *sal* regeneration. Mr. De's experiment has also proved the same with the difference that De has cut it out while they would not have cut it out as they consider it as doing little harm compared to the cost of cutting it out and fire-protecting the area, provided it is burnt early.

As regards Mr. De's remarks that "in Darrang Division also under a normal canopy, profuse *sal* regeneration is found all over the forest where the weed-growth is kept in check" and that regeneration has been accomplished in Goalpara, Nowgong and Darrang Divisions in 4—5 years" and therefore that fire is not a silvicultural necessity in this type of forests for inducing *sal* regeneration, the author desires to state that the undergrowth in the places mentioned by Mr. De in the Darrang Division is either light thatch

or *Eupatorium* which has supplanted it, directly created by burning. This thatch and *Eupatorium* have been repeatedly cut and pulled out in weeding to establish the reproduction in Darrang. This only goes to prove that the creation of conditions favourable to the formation of a thatch ground cover by burning has helped in establishing *sal* seedlings quickly by weeding.

Mr. De's reference to the type of forests is pertinent to the question. A forest type is not a static thing, and the present type is maintained as such by burning only. The position of the forests in Goalpara where also Mr. De claims to have established reproduction by weeding without fire is well illustrated in the note recorded in 1914-15 by the late Professor R. S. Troup, then Central Silviculturist, who toured the forests that year.

"*Cleanings.*—These have been carried out extensively in the Jalpaiguri Division, the working plan prescribing annual cleanings for five years after the fellings in order to free existing *sal* seedlings; in no case have these cleanings succeeded in establishing the regeneration and the reason is not far to seek when it is considered that the failure of regeneration is, as explained above, due to excessive soil moisture apart from any question of suppression. . . . In Compartment I of Ripu Block, Goalpara Division, intensive cleanings have been carried out annually from 1911-12 to 1914-15 over an area of about 140 acres in a somewhat moist type of high-level forests, along the well-drained high bank of a stream where *sal* seedlings are fairly numerous. No established saplings can be found in spite of 4 years' cleanings."

Continuing, Mr. Troup records that "observations throughout the Duars forests show that cleanings have entirely failed to secure the establishment of natural *sal* seedlings, which is what might be expected, since cleanings on a practical scale could not possibly result in an appreciable reduction of soil moisture."

After well-nigh 26 years of effort in burning the forests since the above note was recorded which resulted in removal of this unfavourable soil condition, Mr. De blithely remarks that in the very same forests fire is not a silvicultural necessity in inducing *sal* regeneration. If, acting on this conclusion of Mr. De, fire-protection is introduced in the very same *sal* forests, just as in the case of the original fire-protection, a silviculturist visiting the forests about 30

years after the adoption of Mr. De's prescription will probably record the same observation as Mr. Troup did. Mr. De, who finds evergreen weeds so easy to tackle, must indeed be a man of very different calibre from his predecessors of Troup's time who found the task impossible.

It is regrettable that Mr. De could not find in all his experience in the Garo Hills interior reserves where there is no grazing worth the name and no weeding *sal* regeneration induced, not to speak of established, in abandoned *jhums* subject to fire. A perusal of the 1907-08 Progress Report of Forest Administration will show that the Divisional Forest Officer, Garo Hills, called attention to the unsatisfactory nature of *sal* reproduction in the fire-protected reserves of his Division while vigorous reproduction of the species had been noticed in the unprotected tracts. Both in the Darugiri, Songsak and the proposed Narengiri Reserves where grazing is, practically speaking, absent, burning general and weeding absent, I am prepared to show Mr. De both established and whippy reproduction occurring in thatch.

The same fact can be observed on some of the ridges of Gorbhanga Reserve and Unclassed State Forests of the Kamrup Division, where neither grazing nor weeding but only burning has taken place.

In the Division where Mr. De did all his experiments the present Divisional Forest Officer, Mr. Stracey, discovered in Bamba IX, an area Mr. De must have visited frequently as it was a P.B.I. area, both whippy and established regeneration growing in thatch where neither weeding nor grazing had occurred. A visit to these localities will undoubtedly widen Mr. De's experience.

The author does not minimise the beneficial effects of light. This has been recognised for a number of forests.

As regards the cost of burning, burning initially costs annas eight to one rupee eight annas per acre in open grasslands but the cost becomes less and less as the years progress; in any case it is better to incur this cost than to revert to conditions recorded by Mr. Troup by equally costly and much more uncertain fire-protection. Even so redoubtable an investigator into *sal* natural regeneration problems as Mr. E. A. Smythies in the U.P. came to recognise the beneficial effects of controlled burning and whether it is a concomitant evil or not in the U.P. they have realised that thatch created by burning has got a part to play in the natural regeneration of *sal*. Mr. De remarks that early burning causes the death of many seedlings. Whatever the proportion—and it is not high—it is not necessary or desirable that every seed that germinates should progress towards establishment as otherwise there will be no growing space for the seedlings which will involve expenditure in weeding

out the seedlings. It is enough if sufficient seedlings survive to progress towards establishment within a reasonable period over prescribed areas.

As regards Mr. De's remarks under grazing, for once, the author is in entire agreement with him except as regards his remarks about Moira Nadi. Moira Nadi compartment is not too far away for grazing. Grazing was expressly prohibited here by a divisional forest officer about the year 1932. Consequently, in the broad strips created, a faulty execution of Bor's prescriptions, with the early burning technique, having not been properly practised in the initial years, the grass became too coarse, high and unpalatable to cattle. When the area was inspected by Mr. Milroy in September, 1934, the grass was at least eight feet high in the open strips. Practically no grazing went on in spite of permission to the villagers accorded by the author in these high grass areas but by 1937 the height of the grass had been reduced mainly by forced early burning to about five feet. There are sceptics in regard to the possibility of the reduction of the vigour of the grass by forced early burning but that it is possible has been the author's experience. It is also logical that when the blades are killed down by fire early in the season with the result that these food-manufacturing devices do not function for a great part of the year, the grass rhizomes are not able to store sufficient food-material to send out vigorous shoots next year and as this process is repeated for a number of years, the vigour of the grass is reduced.

The vital differences between Mr. De's method in small experimental plots and the Kamrup method are: (1) Mr. De weeds his areas clean to the exclusion of everything but *sal* seedlings. The Kamrup method prescribes only cutting of shrubs interfering with the growing tips of seedlings and permits the light thatch which has been created by controlled burning to persist. (2) Mr. De fire-protects his reproduction. The Kamrup method prescribes controlled burning of the undergrowth around the reproduction during the cold weather when labour is easily available. (3) Mr. De desires fairly close or even full canopy, thus prohibiting yield from P.B.I. in initial years. The Kamrup method prescribes spacing of *sal* mother trees and removal of middle cover wholly or in stages, permitting removal of yield in initial years. Mr. De has established reproduction in three to four years. The Kamrup method in six years has produced established reproduction from whippy reproduction in areas mostly ruined by faulty treatment under Bor's plan and also produced more whippy reproduction. As Kamrup has whippy reproduction wherever regeneration is required, Kamrup is not bothered by *de novo* regeneration but knows that by the same methods it can regenerate *de novo* in the regeneration period prescribed.

Mr. De concludes with his agreement with Mr. Rowntree that prior to the adoption of rains weeding and *Eupatorium* pulling, any regeneration that came up in Kamrup must have been due to grazing and burning and not to burning only. I have quoted instances of reproduction existing in the Gorbhanga Reserve, in the Gorbhanga Unclassed State Forests, in Uttar Sandubi Compartment, all in the Kamrup Division, existing in thatch where no grazing had taken place; on the top of the Honi Lara Hill, Sajjanpara Compartment also in the same Division and other places, the author, before initiating tending, found numerous seedlings growing in thatch in annually burnt areas. In fact, over most of the ridges, as remarked by Dr. Bor in his plan, there were certain amounts of whippy and sometimes fleshy *sal* advance reproduction, most often growing in thatch. No cattle had ever reached there and the remark that grazing is primarily responsible and not fire cannot hold good in these instances.

From the above remarks it will be apparent that fire has played a very important part in the regeneration of *sal* in Assam, firstly by maintaining the *sal* forest as the climax type, secondly as a measure which under suitable canopy conditions facilitates the formation and survival of reproduction by inducing the light variety of thatch under which alone *sal* seedlings can best survive without weeding for any number of years. Any rejection of the judicious use of fire in Assam Sal Forests—of which there is no danger for the next decade in spite of Mr. De's discoveries—will only result in the creation of conditions which led to the following remarks being recorded by the Inspector-General of Forests in 1914-15:

"I hold that the new treatment (taungya) should be introduced as soon as possible, for I am convinced that only by these means can we prevent the disappearance of *sal* from these forests. . . ." That Assam has had not to adopt artificial methods for the regeneration of its *sal* forests as advocated in the above note is due to the unflinching faith, great perspicacity and inspiring guidance of its late Conservator, A. J. W. Milroy, and though his detractors now seem to abound for purpose of self-glorification, it can no whit affect the magnitude of his achievement.

THAT BEETLE HITLER!

No fake is this Indian-Tree Bug, whose yellow and green markings provide the grumpy likeness of Hitler. That's what he's feeling now. Tree-Bug's name is *Catacanthus incarnatus*. It is found in Western India (and, strangely enough, not in Germany!—Ed.)

M. B. Busheri,
25 Turner Road,
Bandra, Bombay.

LORANTHUS PEST AND ITS CONTROL

BY R. N. DE, I.F.S.

Forest Officers are quite alive to the occurrence of insect, fungus and other kinds of pests found in our forests, but their attention does not seem to have been much focused on the danger of the presence of the parasite, *Loranthus* (including *Viscum*), on our important timber species. Now and then we have read of the difficulties of making plantations of *Gmelina arborea* owing to its susceptibility to attack by *Loranthus* or defoliators and many forest officers are, therefore, reluctant to grow this species in their plantations. Yet it is one of the best species for veneering furniture and other purposes. *Loranthus* is not much of a pest in dry localities, but in our damp climate, it is a definite danger.

Loranthuses are of various kinds and different species attack different kinds of trees and shrubs. For instance, the *Loranthus* that attacks *sal* does not attack *Gmelina arborea* and *vice versa.* There is hardly a timber tree grown in plantations in Assam that is not attacked by some *Loranthus* or other, although the incidence varies considerably with the species. Some trees, if not freed, succumb to a heavy attack of *Loranthus,* while others, though very much weakened, can persist for a considerable time. *Sal,* teak, *Lagerstroemia Flos-Regineae, Artocarpus chaplasha, Bombax Malabaricum,* etc., all have their own *Loranthus* pest and it appears to the writer preposterous for any forest officer to give up growing a certain timber tree because it is attacked by *Loranthus.* I append herewith a list of plants with their *Loranthus* parasites from which it will be seen that if one has to give up growing a particular species, owing to the danger of attack by *Loranthus,* hardly any species can be grown in the plantations.

The agency for the distribution of seeds of *Loranthus* is birds. In course of feeding, they move from tree to tree and either excrete or rub their beaks on the branches of trees. Seeds being sticky, they adhere to the branches and germinate on suitable host plants under suitable conditions of heat and moisture.

From tiny inconspicuous seedlings, they soon grow up into big bushes and it is a common sight to see trees laden with the

Fig. I

February 22, 1938. *Photo: R. N. De*
Lagerstroemia Flos-Reginae tree laden with *Loranthus* near Sadikhal, Sylhet Division.

Fig. II

April 3, 1938. *Photo: R. N. De*
Gmelina arborea tree laden with *Loranthus* in Lawacherra Plantation, Sylhet Division, Assam.

Fig. III

February 21, 1941. *Photo: R. N. De*
Gmelina arborea, as in Fig. I, freed of *Loranthus* three years ago, now growing again as a healthy tree in Lawacherra Plantation, Sylhet Division.

weight of *Loranthus* in localities where it is not controlled (Plate 10, Fig. I). All the nourishment that should have been used up for the growth of the tree is now taken up by the parasite, resulting in impoverishment and eventual death of the host plant.

No cheap and effective method of eradication of *Loranthus* is known and under forest conditions it is well-nigh impossible to adopt measures like spraying. Lopping has so far been found to be the only practicable remedy, but it must be done before seed dispersal. The most suitable time for lopping is soon after flowering and before the seeds ripen. This varies with different species of *Loranthus* but, generally speaking, November-December is the best time for lopping off the affected branches. This has the added advantage of the dry weather when climbing is not difficult. A batch of trained climbers can be raised almost anywhere, specially on payment of slightly higher wages. A *Loranthus* has often more than one host and it is necessary to exterminate it not only from all trees in the plantations, but also from the immediate vicinity. Care must also be taken to see that no part of the parasite is left on the tree.

The writer was responsible for growing large plantations of *Gmelina arborea* and great was his surprise when he found the plantations literally laden with *Loranthus* after a lapse of 10 years. It is obvious that those responsible for their maintenance did not have eyes to see the rapid development that was taking place. Attempt was once made to lop the affected branches, but it was said to be of no avail. A campaign for eradication by lopping was started about three years ago, but the first year's work was somewhat ineffective, as the operation continued long after the seeds had been dispersed. Thanks to the enthusiasm displayed by Mr. N. N. Das, the local Divisional Forest Officer, the pest is now under control. Plate 10, Fig. II, shows a *Gmelina arborea* tree before lopping and Plate 10, Fig. III, the same tree two years after lopping. It will be noticed that no more *Loranthus* has developed on it and the tree is as healthy as ever.

It is found that *Gmelina arborea* in certain Divisions and even in different localities of the same Division is somewhat immune from the attack of *Loranthus* and it is thought that some

strains might be hardier than others. Experimental plantations have been started with different seed origin to test this theory.

The following table gives a list of trees and shrubs affected by different species of *Loranthus* as collected by the writer and his herbarium staff in course of their tour. It will be seen that even teak is not spared and that cannot be a reason for discontinuing teak in plantations. It is criminal to allow a pest to spread far and wide and then control it when it has become a terrible nuisance. Remedy is cheap and effective if it is nipped in the bud. What is wanted is constant vigilance and eradication of the pest as soon as it makes its appearance:

Species of *Loranthus*	Host plants*
Hyphear odoratum (Wall) Danser .. (*Loranthus odoratus*)	*Quercus dealbata.* *Quercus fenestrata.*
Helixanthera parasitica .. (*Loranthus pentapetalus*)	*Castanopsis tribuloides.* *Shorea robusta.* *Quercus serrata.*
Helixanthera ligustrina (Wall) Danser .. (*Loranthus ligustrinus* Wall)	*Glochidion oblatum.* *Lagerstroemia parviflora.* *Saurauja panduana.* *Helicia robusta.* *Quercus lanceafolia.* *Pieris ovalifolia.* *Melia azederach.* *Machilus gamblei.* *Phyllanthus Emblica.* *Amoora Wallichii.*
Scurrula Parasitica Linn .. (*Loranthus scurrula*)	*SCHIMA WALLICHII.* *GMELINA ARBOREA.* *Hibiscus macrophyllus.* *Helicia erratica.* *Pterospermum acerifolium.* *Quercus dealbata.* *Cudrania javanansis.* *Glochidion Thomsoni.* *Symplocos* sp. *LAGERSTROEMIA FLOS-REGINÆ.* *Glochidion oblatum.* *Glochidion khasianum.* *Callicarpa arborea.* *Premna bengalensis.*
Scurrula parasitica (*Loranthus Scurrula* var. *bengalensis*) ..	*Myrica Nagi.* *Mucuna monosperma.* *Thevetia neriifolia.* *Grewia microcos.* *LAGERSTRŒMIA FLOS-REGINÆ.*
Scurrula corynitis (*Loranthus globulus*) ..	*Helicia robusta.* *Melia azederach.*
Scurrula parasitica (*Loranthus scrula* var. *laevigata*)	*Ficus hispida.*

*Important timber trees are shown in *CAPITALS*.

Species of *Loranthus*	Host plants*
Scurrula gracilifolia Schul. (*Loranthus Scurrula* var. *gracilifolia*)	*Phyllanthus emblica.*
Scurrula pulverulenta (Wall) G. Don	*Garunga pinnata.*
Scurrula umbellifer (*Loranthus umbellifer* Schul.)	*Melia azederach.* *Vatica lanceaefolia.*
Taxillus vestitus (Wall) Danser (*Loranthus vestitus*)	*Quercus Griffithii.* *Castanopsis Hystrix.*
Dendropthoe falcata (Linn. Fil) Danser (*Loranthus longiflorus*)	*SHOREA ROBUSTA.* *Dillenia pentagyna.* *Premma barbata.* *Ilex Godajam.* *ALTINGIA EXCELSA.* *Eugenia tatragona.* *Helicia erratica.*
Tolypanthus involucratus (Roxb.) V. T. (*Loranthus involucratus* Roxb.)	*Dillenia indica.* *Citrus* sp. *DALBERGIA SISSOO.* *Delima sarmentosa.* *ARLOCARPUS CHAPLASHA.*
Texillus Thibetensis Linn	*SCHIMA WALLICHII.*
Taxillus assamicus Danser	*Helicia erratica.* *Quercus Griffithii.* *Viburnum simonsii.* *Symplocos spicata.* *Elaeocarpus aristatus.* *Glochidion khasiana.*
Macrosolen cochinchinensis (Lour) Van. Tiegh (*Loranthus ampullaceus*)	*Mallotus philippinensis.* *BOMBAX MALBARICUM.* *Barringtonia acutangla.* *HYDNOCARPUS KURZII.* *Saracca indica.* *MANGIFERA INDICA.* *Tectona grandis.* *ACACIA CATECHU.* *Salix tetraspherma.* *Grewia multiflora.* *LAGERSTROEMIA FLOS-REGINEÆ.* *SHOREA ROBUSTA.* *ARTOCARPUS INTEGRIFOLIA.* *Castanopsistribuloides.* *Symplocos theafolia.* *Vatica lanceaedolia.*
Macrosolen psilanthus (Hook) Danser (*Loranthus psilanthus*)	*Quercus glauca.* *Quercus lanceaefolia.* *Myrica Nagi.* *Carpinus viminea.* *Quercus dealbata.* *Quercus lineata.* *LAGERSTROEMIA FLOS-REGINEÆ.*
Viscum monoicum Roxb.	*Bauhinia purpurea.* *Randia dumetorium.* *Punica Granatum.* *Dalbergia tamarandifolia.*

*Important timber trees are shown in *CAPITALS.*

REVIEWS AND ABSTRACTS

BIRDS OF BURMA

BY B. E. SMYTHIES, BURMA FOREST SERVICE

American Baptist Mission Press, Rangoon. Price Rs. 15.

"I always knew, Emsworth, that you were as mad as a coot," said Sir Gregory Parslow. "What's a 'coot'?" asked Lord Emsworth plaintively. "Sort of duck," said the Hon. Galahad.

The volume before us tells us that coots belong to the order *Grallae*, sub-order *Fulicariae* and family *Rallidae*, while ducks are members of the order *Anseres*, family *Anatidae*. Obviously these birds are as different from one another as chalk is from cheese.

The ornithological knowledge of the Hon. Galahad Threepwood (as displayed by P. G. Wodehouse) may raise a smile but it is quite on a par with that of the very large majority of people living in India and Burma. How often do we hear this sort of thing? "Never saw it before, old boy. Looked just like a crow with a couple of long tail-feathers." How many of us can recognize one hundred birds that we meet on our daily round? Supposing we do recognize a few, do we know anything about them beyond their appearance? Are they resident or migratory? What about their habits, songs, nests?

Most of us would like to know something of the birds we see in our compounds and on our walks abroad. Failing a tutor, the difficulty has been how to make a start. Collection and dissection are for the specialist—the amateur wants a well illustrated manual in which the salient points of the species are brought out. The book which lies before us is, we truly believe, one which will be hailed with delight by all those who take more than a passing interest in the living things about them.

The aim of the book, says the author, is to provide a concise and accurate account of the birds of Burma, written in non-technical language, in response to the universal demand for "something not too scientific." This aim has been achieved.

The text of the book has been produced by three forest officers, B. E. Smythies, the author, and Messrs. Smith and Garthwaite, the editors. All three can be congratulated upon a really excellent piece of work.

The extremely careful field notes on habit, voice and nidification are one of the outstanding features of the text and we suspect they have been compiled mainly from the records kept by the editors over a considerable number of years.

Under "habit" an excellent description is given of each species which conjures up a living picture of the bird before the reader.

This is no book for the soulless individual who spends his life poring over musty bird-skins in a museum but one for the nature lover, whether he lives in the town or in the country. And, let us hasten to add, not one exclusively for those who live in Burma, for Indian readers, especially those who live in the Himalaya, Bengal, Assam or Bihar, will find a very great many, if not all, their species mentioned in it.

Most senior forest officers will wish that such a book had been available when they started their service. A good many of us get to know the commoner game birds in time, but the hundreds of others remain for us just "birds." Those who do become birdmen have been lucky enough to come in contact with a man who knows something of the subject and is keen enough to impart his knowledge to a youngster. Those of my colleagues in the forest services who are not silviculturists, entomologists, or lowest in the scale, botanists, but simply good forest officers, will find in this book something that will give an added interest to their lives in the forest.

The coloured plates (31 in all) are reproduced from paintings executed by Lieut. Commander A. M. Hughes, R.N. They are excellent. The American Baptist Mission Press has produced a well-printed and well-turned-out volume.

The book is priced at Rs. 15, of which Rs. 5 goes to the Burma War Donation Fund.

We advise everyone who is at all interested in birds to get a copy of this book.

N. L. B.

EXTRACTS

INSIDE THE SECRETARIAT

Less than a month after his arrival in India Lord Curzon wrote to the Secretary of States for India:

Your Despatch of 5th August arrives. *It goes to the Foreign* Department. Thereupon Clerk No. 1 paraphrases and comments upon it over 41 pages of print of his own composition. Then comes Clerk No. 2 with 21 more pages upon Clerk No. 1. Then we get to the region of Assistant Secretaries, Deputy Secretaries and Secretaries. All these gentlemen state their worthless views at equal

length. Finally we get to the top of the scale and we find the Viceroy and the Military Member, with a proper regard for their dignity, expanding themselves over a proportionate space of print. Then these papers wander about from Department to Department, and amid the various Members of Council. Each has his say, and the result is a sort of literary Bedlam. I am grappling with this vile system . . . . but it has seated itself like the Old Man of the Sea upon the shoulders of the Indian Government.

Government here has become very ponderous and slow. I am prodding up the animal with most vigorous and unexpected digs, and it gambols plaintively under the novel spur. Nothing has been done hitherto under six months. When I suggest six weeks, the attitude is one of pained surprise; if six days, one of pathetic protest; if six hours, one of stupified resignation!—*Capital,* dated November 21, 1940.

FORESTS AND EROSION*

By Professor E. P. Stebbing

The native British Woodlands have been so largely destroyed and existing woods are now so extensively the results of planting and replanting, says Mr. A. G. Tansley,† that foresters are naturally inclined to think of them all either as plantations or as derelict and worthless wood or scrub, of value only as possible sites for new plantations. It is to be feared that the accusation is correct. Many foresters quite lose sight of the value and importance of a study of the historical past of a forest region or area which may have been once afforested. Evidence is often present in the remains, obviously native, of old woods or forests, perhaps as small isolated blocks or individual trees standing in a great stretch of cultivation or of badly degraded grazing lands. In the densely populated countries of Western Europe are to be found perhaps extensive "semi-natural" forests, or, as so commonly in Britain, small woods, which have been consistently exploited and sometimes partly or wholly naturally regenerated or replanted with native trees. "With such assistance,"

*Reprinted from "Journal of the Royal African Society," January, 1941.

†"Natural and Semi-Natural British Woodlands", by A. G. Tansley, F.R.S., in *Forestry*, Vol. XIV, 1, p.1. Oxford Univ. Press, 1940.

says Tansley (who deals with Britain only, but the contention applies equally to Western Europe), "it may be possible to rebuild a fairly complete picture of the former primeval forest which covered the countryside. Gaps there will be. Certain areas will have been deforested for agriculture or pasturage so completely that no trace or evidence is left of the forest vegetation which once clothed them. Or long and excessive exploitation (combined with firing) of the forest may have so changed its character that its original state can only be guessed at. On the other hand, if a destroyed area is protected from pasturage and no longer used for the growth of crops, it very probably becomes reafforested again." An excellent example is the redevelopment of beech woods in the Goodwood region of the West Sussex Downs. Here the succession from grassland to beech developing from natural seedlings may be seen; a perhaps commoner example is the appearance of young Scots Pine on Commons in Southern England, and in the New Forest and so forth.

It is instructive to realise that deforestation through excessive exploitation and grazing, annual firing of the countryside and so forth, is not necessarily a product of the tropical regions of the world only. It has been witnessed in the temperate portions of the globe, and in Britain itself.

The Neolithic peoples, the first inhabitants of Britain to keep flocks and herds and to till the soil, were present during the late Atlantic (about 3500-2500 B.C.) and early Sub-Boreal times (2500-500 B.C.). Their occupation coincided with increasing dryness of the climate, and they lived on the drier soils, e.g. the wind-swept crests and spurs of the chalk where forest was thin or absent—the Wiltshire Downs, for instance.

During the Sub-Atlantic, the old Atlantic forest, mainly dominated by oak, maintained itself, and so did much of the Sub-Boreal pine and birch forest of the Scottish Highlands, though pine disappeared from Ireland and probably from parts of Western Scotland. The sphagnum bogs extended again, forming the newer peats, and some have continued to grow until now; though latterly there has been much peat erosion, especially on flat summits.

With the coming of metals, the Bronze Age peoples, during most of the Sub-Boreal, extended pasturage and cultivation and began to push the forests back, though great areas—the Weald and the Midland Plain areas, for example—were untouched because still uninhabited. These were the first early efforts at deforestation in Britain, and they have continued to this day.

Coming to the historical period, forest vegetation was more rapidly destroyed as the population increased. The felling of trees for timber and the cutting of the coppice underwood for firewood, tools, and various other purposes accompanied the use of the forest for pasturage and tillage, especially by the method known as shifting cultivation. "The pasturing of cattle," says Tansley, "was also extensively practised in forest and inevitably led to the death of the forest and its conversion into grassland. The proportions of arable and pasture fluctuated backwards and forwards during the centuries, but on the whole the trend has been to increasing predominance of pasture, for which the climate is particularly well suited. In the late Middle Ages and throughout the modern period right up to the 19th century, sheep raising was the main rural industry, on which the great wool and cloth export trades were based."

We were importing timber as early as the 11th century; in the 13th and 14th centuries it was brought in, in considerable quantities, from the Baltic countries to the north-east coast; though as late as the 15th century, timber was still being exported from the Weald. Finally, it was in the 17th century that the last reserves of the native English forests were exhausted and England became definitely dependent on foreign supplies. Through their fortunate climatic position, the equally fortunate fact that they could obtain nearby supplies from Scandinavia, in what appeared like inexhaustible amounts, and more fortunate still that they were able to pay for them, the British had never known and never had to bother about forestry or what it really entailed; nor had any practical experience of the ways in which Nature may take her revenge for the wanton destruction of her forests.

Briefly, Tansley's thesis is that for any given type of soil the old type of forest particular to the soil and locality will reappear,

given a chance to do so. That the old forest of, say, the South of England still persists in the many examples of Coppice with Standards where oak is so commonly one of the chief species among the Standards. That with the exclusion of man and his flocks, and the rabbit and hares in excessive numbers, Nature would restore in time the same type of forest as originally existed on so large a part of the island. It is beyond doubt that in some counties this claim can be substantiated by careful observation. In parts of the Kentish Weald oak is a predominant species. In fertile conditions it will be found as seedlings, on lawns, flower beds, and in shrubberies coming up almost in the form of a weed. And this in a temperate climate! What results may be expected in tropical countries?

If we consider this question out in the British Empire, we see the same processes at work which resulted in the disappearance of the greater part of the forests of Great Britain. But with the temperate island climate this latter disappearance did not prove detrimental to the people of Britain, who waxed rich and prosperous through their industries and obtained all the timber and other products of the forests at will by imports. As a people, therefore, we failed to recognise that conditions might be very different in tropical countries; that, in fact, a *laissez-faire* policy in permitting the unchecked exploitation of the timber forests by contractors or their wasteful utilisation by the local population might result in a quicker degradation of the forests and their ultimate disappearance with disastrous effects to the country concerned. These inevitable consequences have proved very difficult to inculcate among those responsible for the civil administration of these countries. So conservative is the British outlook and so fixed were the principles laid down of old that no interference should be made with the habits and customs of the numerous races who gradually came under British governance, that it is not too much to say that the Administrator was, through a considerable period, quite unable to grasp the fact that many of the habits and modes of life of the people were directly at variance with some of Nature's most rudimentary laws. Land areas had sufficed for the population in the past. Why not now? Under the Administrator's beneficial rule populations had perhaps doubled, their flocks quadrupled, and the forest lands greatly decreased and degraded. Decade succeeded

decade but the true relations of these factors remained ignored or disputed.

It is not that attention was not repeatedly drawn to the increasing poverty of lands and soils through various forms of erosion, and the threat to the water supplies. Scientists and experts have (the subject was first ventilated in India nearly a century ago) repeatedly warned the Governments of the day. The result had been a laudable issue of rules and regulations which remained a dead letter. A perusal of the Annual Forestry Reports for a considerable number of the Empire Forest Services reproduces a similar state of affairs. In that of the Gold Coast for 1938-39 we read: "Forestry in the Gold Coast presents the story of a chequered career. The foresight prompting a departure, some thirty-one years ago, from the orthodox, or wholly commercial, form by stressing the indirect value of the maintenance of a proportion of tropical lands under forests is now amply vindicated. But good advice is one thing; its adoption is another. Forests, of necessity, occupy land; and difficulties are not lessened when all that land, although surplus to immediate wants, is owned by a community with an unawakened national sense: to the individuals the cash resulting from an immediate sale is much to be preferred to what may appear to be an almost altruistic use by reservation. And the African is not unique in this respect." It is an old story.

With the object of introducing some order and control in the exploitation of the Malabar Teak Forests in the Madras Presidency a Conservator of Forests was appointed in 1805. Owing to the enhanced demand for teak by Government Departments and the population, intensive and wasteful fellings had enormously increased. The Conservator soon established a Government monopoly, a permit having to be obtained by all wishing to exploit teak. The policy was resented by timber contractors and the public, and eventually the growing opposition led to the abolishment of the conservatorship in 1823 and the throwing open of the remaining accessible teak forests to indiscriminate fellings. In his Minute abolishing the conservatorship, the Governor, Sir Thomas Munro, said that the merchants and agriculturists were "too good traders not to cultivate teak or whatever wood is likely to yield a profit.

They are so fond of planting. . . . To encourage them no regulation is wanted, but a free market. Restore the liberty of trade in private wood: let the public be guarded by its ancient protector, not a stranger, but the Collector and Magistrate of the country, and we shall get all the wood the country can yield more certainly than by any restrictive measures. Private timber will be increased by good prices, and trade and agriculture will be free from vexation." This pious hope showed a complete ignorance of the point of view of either private proprietor of the forests or the timber contractor, and sounded the death knell of the accessible teak forests in Malabar, which by 1833 were cut out. The opinions expressed in Munro's Minute had a detrimental influence on the progress of forestry in Madras throughout the following half century.

This inability to grasp Nature's basic laws governing the forests, and their presence on the countryside at the time of the advent of British control and the influence they were exercising, has been one of the deficiencies in administration of some of our Colonies.

The position, or one side of it, which this question has taken is to some extent given by the following (also from the Gold Coast Report). "The need for reservation (of forest) although foreseen was not pressed at the time when surplus land was plentiful. Confusion with other issues occupied two decades and subsequent reservation had to be carried out conjointly with the education of the community and a rapidly diminishing area of forest land. Opposition was not wanting and, on occasion, every yard of a boundary line was contested. Opposition is not yet dead; but there does exist to-day, where there did not exist before, an enlightened section of the community which can appreciate the need of forest reservation."

A more important point would appear to be the question whether enough forest has been left within the confines of the Gold Coast to maintain and improve agriculture generally, maintain the water supplies, and to control erosion; and to supply, apart from foreign markets, the requirements of the future population.

The following extract from the Annual Forestry Report for Nigeria, for the year 1939, shows a similar state of affairs. It deals with the Southern Provinces: "No new reserves were constituted,

the main concern in all circles having been the amendment and consolidation of existing reserves. Political and legal difficulties and problems of land tenure are obstructing progress in new reservation, but a plan for the formation of "clan" reserves in the Ubiaja Circle shows some promise, and it is hoped before long to constitute an aggregate of nearly 200 square miles of such reserves in the Ishan and Kukuruku Divisions of that province. The idea is similar to that underlying the plan of Communal Forestry Areas in the north in that it is hoped to develop a sense of communal ownership: the only serious difficulty arising from the fact that inter-clan boundaries are indefinite.

"There can be no question in the mind of any trained observer that all the forms of deterioration referred to in the first paragraph of this Report are in active progress in various parts of the Southern Provinces, but there can be little hope of more than local remedy until the chaotic situation as regards land tenure has been resolutely tackled. Referring to certain reconnaissance work carried out in the Enugu Circle in connection with the problem of soil conservation in the more severely eroded regions of Awka and Onitsha, the Circle Officer comments laconically: 'Most of the forests of these Divisions have already gone and the soil is now following the forests'."

As Lord Hailey's *An African Survey* well demonstrates, the soils of the African Continent are for the most part poor and desiccation appears to be becoming a problem of increasing importance over considerable regions. It is the causes of this desiccation so far as it affects the population as a whole which have been neglected in the past, are in dispute in the present, and appear to threaten existence itself for a considerable portion of the inhabitants in the future.

The effects of deforestation when accompanied by the felling and disappearance of areas of heavy high forest are appreciably evident on a countryside, and their destructive results may in these days become visible within a short space of years, e.g., the United States Dust Bowl. It is otherwise, however, in the case of large regions of degraded forest, bush or savannah in Africa, which the people are able to exploit at will for a temporary agriculture, overgraze, or annually fire. Much of these areas was originally high

forest. The right of ownership by Chief and people has been recognised. Therefore no interference has been placed upon the rights of user, with the result that the so-called bush is degrading rapidly, a process leading to an intensification of the desiccation.

It has been said that opinions differ on the subject of desiccation and its causes on the African Continent; but it is admitted that desiccation is taking place in some regions.

The Governments of the African Colonies have not yet, it would appear, fully grasped the vital influence of all the high forest remnants left within the parts of the Continent subject to British jurisdiction; nor the value of the savannah forest, degraded as it is, nor its recuperative possibilities under adequate protection. The example quoted above of the results of Sir Thomas Munro's Minute in Madras has been repeated many times since.

As a result of the war, the Forest Departments of the African Colonies have been reduced by permitting the junior officers to join the military forces, and the cessation of further recruiting. This action has been unfortunately taken at a time when an urgent call is now to be made upon the forests to provide for the requirements of the armies of the Middle East—as was the case in the last War, when India supplied the army in Mesopotamia with the bulk of its requirements in timber and other forest produce. But India had a forest staff of sufficient strength to see that the extra fellings necessary to provide for the calls were undertaken under supervision; the forests concerned were under working plan management and their potential possibilities were known. In other words, indiscriminate felling did not take place in any of the State Forest areas throughout the country.

In the Annual Report of the Forest Department of Kenya for 1939 we read: "The outbreak of war caused some reduction in staff but considerably increased the demand for forest produce. . . . A considerable increase appears in the log consumption for 1939 over the previous year. This was due to an expansion in local trade which was evident in the first nine months of the year, but which was intensified in the last three months of the year by military demand." Elsewhere this factor is described as "the urgent military demand for building timber."

This will entail extra fellings, probably heavy fellings, in the forests. Under what competent supervision will these fellings be made? The Department has been reduced to nine European trained officers (including its head, the Conservator) with a subordinate staff, mostly untrained. Any other of the half dozen Forest Departments in Africa is in the same position. Since the Middle East armies, under the decisions taken at the Delhi Conference, are to be supplied from the countries to the East, it looks as if considerable calls may be made on the African Rain and Deciduous High Forest. Such fellings, unless under expert supervision, will inevitably result in a further depreciation in the growing stock of a forest area which has already reached a dangerously low level.

In Great Britain there has been no question of recruiting for military purposes among effectives indisputably necessary in the industries and factories undertaking the provision of war materials of all types. If timber and forest produce are equally required from the tropical forests for military use it would appear a logical conclusion that the expert trained staff should be sufficiently numerous to supervise the work of extraction and supply. The danger of sudden excess fellings in forests whose possible volume-output is imperfectly known, and whose existence is probably a necessity to the maintenance and possible improvement of agriculture and climatic conditions in the future, are well known. It is difficult to see how the trained expert responsible for this work differs from the equally trained experts in charge of the industrial war output of Great Britain—save that in the one case the man-in-the-street can appreciate the necessity; while the other, save to a few, is unknown.

War fellings in tropical and semi-tropical forests, unless under expert supervision, are merely a reversion to the old type of indiscriminate exploitation under which so much tropical forest has become degraded or disappeared, resulting in erosion, desiccation, accompanied by, in the earlier stages, violent flooding. These results are nowadays at least indisputable.

Another point which merits a comment is the destruction of forest which has always taken place in regions in which opposing armies are operating. Large regions in Africa formerly occupied by man are now desert. Military acts, such as firing the countryside by

a retreating army, or ruthless destruction by the conqueror, have in the past assisted, combined with the wasteful methods of livelihood of the populations, in the final disappearance of the vegetation.

Warfare of the present day in the so-called deserts of the press—mechanised warfare—is a very different proposition. The armies are or will be operating over extensive regions of the African bush or savannah upon which the people so commonly depend for their farming or grazing their herds and flocks. What will be the condition of these areas when Hitler has been beaten? It appears to be a point worthy of consideration now, and not relegated to a belated future.

Instances of countries which strikingly show the results of misuse of vegetation and soil factors are not wanting in the British Empire. Palestine forms an interesting example. A small Forest Department was inaugurated in 1936. Its coming almost coincided with the outbreaks and unrest which supervened so soon afterwards, so that promised grants were not available. But the Department has already been able to contribute some information of value on the subject of erosion in the Middle East.

In a report covering the period 1936—39, it is stated that the total land area of Palestine is some 10,000 square miles; the hills are mostly composed of limestone with basalt intrusions in the north-east, whilst the plains are deeply covered with alluvium. The climatic desert accounts for something less than half the area; of the remainder forty-five per cent. is plains, and fifty-five per cent. hilly country. The state of the hills is considered to be unsatisfactory, as most of the surface is eroded and probably less than one per cent. is agricultural land in good condition. The hills, it is said, were undoubtedly once covered with soil and forest, whereas they are now an artificial desert due to overgrazing. The river valleys are desolated by floods and the deposition of infertile detritus; the river beds are choked, and road and railway embankments and bridges frequently damaged.

On the subject of erosion and land reservation the report states: "In the course of time previous to 1936, the natural vegetation was cleared from nearly all the fertile areas of Palestine, and such vestiges as remained were on the most rocky and barren land. Even there

the vegetation was almost ruined by excessive grazing and uncontrolled cutting. In consequence the present value of the vegetation and of the land on which it stands is very low, and most of the Forest Reserves cannot be made highly productive without many years of careful management. Closure and protection, however, will very early result in the checking of erosion and flooding, and are therefore of the utmost value."

There appears little doubt that man and his wasteful habits—fire and excessive grazing—have been the two chief causes of the present condition of so much of Palestine. Treating of fire, the climate of the country with its long summer drought, atmospheric desiccation and dry hot winds is very conducive to forest fires, which would be more serious but for the sparseness of the vegetation in most places—which tells its own tale as to the degrade of the country as a home for man; or even for his goats. The present position of grazing shows the determining factor in this latter question. The following paragraph might have been penned for other areas within the British Empire; but here it possesses its own significance:

"Except for the well-bred cows on a few modern dairy farms which grow fodder in irrigated fields, the grazing animals of Palestine have to depend on the grass, shrubs and young trees which Nature provides on uncultivated land. Their only change of diet is the stubble on the cereal lands after harvest. Centuries of such treatment have produced a tough and agile goat which can consume organic matter of almost any type. The sheep, mostly of the fat-tailed breed, are also very hardy. The camel, fortunately less common in the northern districts, eats what the goat cannot reach. No attempts have been made to estimate the permanent carrying capacity; the number of animals grazed is limited only by drought, starvation and disease; and the vegetation is destroyed over large areas, which have become artificial deserts in spite of good climatic and geological factors. Soils were nearly everywhere excellent before they were removed by erosion. All other forms of damage fade into insignificance beside the destruction caused by grazing, though the process is accelerated by cutting and uprooting."

And yet there are still some who dispute that obvious factor on the globe, the man-made desert—of the past, of modern-day origin, and in the making.

The controversy on Palestine which took place in the House of Commons in February, 1940, in connection with the extending purchases of land by the Jews drew attention to this difficult problem and the most desirable procedure for obtaining control of the degraded lands which need treatment. Title deeds are said to be at present obscure, and land settlement, it is thought, must be in some regions long delayed. If the condition of the country is to be improved, it is considered inevitable that legislation must provide for state control of certain land, both public and private. Some form of rural planning must be undertaken, which will probably provide for the improvement of ruined land over a period of years, to be followed by its allocation to a use which will prevent the repetition of its former destruction.

As an instance of the final aftermath of these processes, although Palestine itself forms a serious illustration, a brochure by Mr. C. Swabey entitled *Forestry and Erosion in Haïti and Puerto Rico* (Government Printer, Kingston, Jamaica, 1939) affords some striking lessons. Mr. Swabey is Conservator of Forests in Jamaica and his Government arranged for his visits.

"Information concerning forestry activities in Caribbean countries other than British Colonies has always been difficult of access," says Swabey, "and it was felt that it would serve a useful purpose to make a brief study of conditions in Haiti and Puerto Rico where deforestation and erosion problems are known to be serious."

Speaking generally, the economy of the West Indies as a whole is based primarily on four major factors: (*a*) limited land areas; (*b*) rapidly increasing population; (*c*) complete dependence on agriculture; (*d*) decline in value of primary export crops. The chief exceptions to this general truth are Santo Domingo and Trinidad. Extensive methods of agriculture and high export crop prices combined with a limited population in the past spelt prosperity without an over-utilisation of land values.

To-day the position is far otherwise and very instructive. "Intense pressure of population has pushed wasteful cultivation methods on to lands quite incapable of supporting them. The resulting deforestation and soil losses have caused problems of major

importance; it has therefore become necessary to take steps to conserve soil and water resources and at the same time to provide land for the rapidly swelling population."

Haiti is a republic containing some 3,000,000 of a population with a land area of 10,204 square miles (294 head per square mile). The extent to which deforestation has proceeded is nothing short of appalling (Swabey); apart from the coastal limestone hills of small rainfall which have a certain amount of scrub growth and a few thousand acres of degraded mountain pine forest, nothing is left of Haiti's forests. "The effect of this denudation on the economic and social life of the country is disastrous: general rural impoverishment caused by soil losses and reduction of soil fertility marches hand in hand with an ever-mounting bill for flood damages, gradual desiccation of once fertile valleys and depletion of water resources both for domestic and irrigation purposes. In many districts even firewood is difficult to find; timber for constructional purposes is universally lacking."

Omitting the flat arid plains, the coastal belt of mangrove swamp, and some dry coastal scrub, the following presents the condition of the rest of the country. Inland in the hilly moist areas, timber trees have almost entirely given way to cultivated crops, the only semblance of forest cover being given by coffee fields with their shade of *Inga vera*. In the great central plateau region, north of Hinche, the original pine forests (*Pinus occidentalist*) have given place to over-grazed, annually burnt, coarse pastures of grasses. Sheet and gully erosion of this savannah land is steadily reducing its stock-carrying capacity.

The instability of land ownership appears to be a formidable bar to securing satisfactory land use. Decrees and laws have been enacted to check land abuses, felling abuses, the burning of savannah lands and so forth, but they have virtually remained a dead letter.

Past administration cannot be said to have been very long-sighted or to have envisaged the true interests of the population, either present-day or future.

Puerto Rico was ceded to the United States in 1898 after the Spanish-American War and is administered as an integral part of the U.S.A. The territory has an area of 3,400 square miles, a population

of 1,700,000, and a density of 506 to the square mile, which is much higher than Haiti.

Puerto Rico conforms to the Greater Antillean pattern having a central mountain chain rising to 4,400 feet of igneous and residual volcanic material surrounded by coastal plains of alluvium or low limestone hills. Rainfall in the mountains is as high as 250 inches per annum, while on the southern leeward plains it falls as low as 20 inches. Economic utilisation conforms to the West Indian pattern, sugar being the dominant crop, which monopolises the fertile lowland soils, coffee and tobacco being relegated to the uplands, where they form the principal cash crops. "The density of the population," says Swabey, "has resulted in unsuitable agricultural methods and excessive deforestation, followed by the inevitable erosion problems. The extraordinary cohesive nature of the volcanic soils has made it possible to maintain some sort of cultivation on slopes which, in other islands, would now be completely unproductive; but, in spite of this, the problem of land misuse is one of basic importance to the island."

The first forest administration came into being in 1917, the only reservation before this being the Luquillo National Forest of 12,400 acres, an old Spanish Royal Forest. The new administration was called the Insular Forest Service, and took over certain areas of land as Insular Forests, and a little planting was done. Small progress was made till 1933, when forestry operations were commenced by another organisation, termed the Civilian Conservation Corps (C. C. C.) with funds of its own: two years later the Puerto Rico Reconstruction Administration (P.R.R.A.), also with its own funds, came in to assist. Thus from the forest officer's point of view, similar types of work were financed by four different organisations, viz. the U.S. Forest Service, in supreme control of the forest areas, the Insular Forest Service, C.C.C. and P.R.R.A. There is one Forest Supervisor who is responsible for co-ordinating the work of the four organisations, and he is under the direct orders of the Regional Forester of the U. S. Forest Service at Atlanta, Georgia.

In the past five years the amount expended on forestry work to attempt the restoration, in part at least, of areas destroyed by erosion, etc., as the direct result of man's ignorant and unchecked activities was over ten million dollars, an average of £400,000 per annum.

This enormous expenditure, or programme, has been made possible by C.C.C., which may be looked upon largely as a relief organisation, and by P.R.R.A., a local product of President Roosevelt's New Deal programme. C. C. C. camps have been established in most of the forest units, and have been engaged in extensive road-building and other constructive works, in addition to replanting work. P.R.R.A. funds have been used in a similar fashion, and also for the purchase of further areas of land for forest Reserves. The chief trouble experienced by the Supervisor is in the fluctuating funds available from the different organisations, thus rendering it difficult to forecast definite programmes, as, e.g., the annual planting area, and so forth. In March, 1939, the total forest area so far acquired amounted to 87,752 acres, representing 4 per cent. of the total land area. The Forest Department aims at a total area of State Forest of 250,000 acres or $11\frac{1}{2}$ per cent.

As Swabey remarks, and other forest officers will note, there is an interesting contrast "between the £5 per acre per annum spent on the forest area in Puerto Rico and the ninepence per acre per annum in Jamaica!"

An interesting aspect of forestry as undertaken by Americans is the application to a tropical island of the conception that the forest can be regarded as a recreational area. The forests have been opened up with wide asphalted motor roads; there are restaurants, week-end bungalows, swimming pools, trails, shelters, outlook towers, etc., and a trained landscape artist in charge; and the Forest Service has its own aeroplanes, launches, yachts and motor cars. "The tents and bush huts of the British Tropics," says Swabey, "give place to concrete bungalows, electric light and tiled bathrooms." Swabey appears to doubt the "recreational appeal of a damp tropical jungle as compared with that of the pine-needle floors or shadowy glades of northern climes." He admits that "the tourists apparently like it." The idea is not, however, entirely new, nor is it confined to Americans. In the Banco Forest Reserve, situated a few miles distant from the capital, Abidjan, of the Ivory Coast in West Africa, the French were developing the same idea with the object of attracting tourists and of affording amenities for the resident French population in the capital. Banco comprises some 8,000 acres in the Rain Forest belt, and the French forest officers were treating it as a

Champ d'Expérience for sylvicultural work. The Governor had, however, provided the money for a wonderful network of well-graded motor roads. These are marked by signposts into three categories, for a short drive, afternoon drive, or a day's excursion round the forest. Banco is adjoined by a forest area (as yet undeveloped) of twice the size. Although Banco had not (six years ago when I visited it) arrived at the restaurant stage (or cocktail bar), it had a much frequented and picturesque bathing pool situated at the bottom of one of the attractive gorges. I admit that in India I should never have thought of bathing in what seemed such a malarious spot—but it was very popular with the French.

Swabey also notes that it was a pleasing feature to see the roads of Puerto Rico, in both town and country, lined with ornamental and shade trees. "The contrast," he remarks, "between the tree-lined roads running through the open cane districts, and similar bare and dusty roads in the British islands is extremely striking." Here again the French have always been in the van with this kind of humanising planting. I remember a striking illustration. We had left behind the northern village of Jibia and crossed the frontier between Nigeria and the French Niger Colony—the countryside sand-covered, with a poor type of savannah bush. A few miles to the north we reached the first French town, Maradi, to find houses embosomed in trees and the roads lined with them. The effect, as I remarked at the time, recalled the Bois de Boulogne. The trees were the result of careful attention by the political officer. In the Ivory Coast I observed numerous instances of a similar attention. One wonders why we are so extraordinary negelectful in this respect. Early in last century the lining with trees of the grand trunk roads built in India was undertaken, and many of us have enjoyed the benefit of the shade of these wonderful old avenues. A century elapsed before the enthusiasm of the Viceroy of the day, Lord Curzon, started another road tree-planting campaign in that country. Quetta was absolutely transformed from a bare frontier station to a small paradise when the roads were planted with willows and poplars. But usually we have been content with the existing hot, dusty, glaring roads, both in the station and out on the countryside—because we have not the knowledge to change them.

With the exception of parts of the Luquillo Reserve, the remaining forests of the island are second growth and contain but little timber, the bulk of the acquired land having been under cultivation; much of it is open and grassy and, from a timber point of view, unproductive. "At the same time," Swabey points out, "the very heavy pressure of population makes it imperative that all land which can produce any food crops should be permitted to do so. For this reason, the *parcellero* system, a modification of modern *taungya,* has been adopted in many afforestation projects." This is rather interesting. A "parcellero" or peasant contractor is allowed an area of fifteen acres. He resides on this parcel indefinitely, gradually cultivating and establishing trees over the whole area: as the trees attain thinning size he will obtain advice and labour for the work and for the marketing. The scheme is sound for regions such as Puerto Rico, where land hunger is acute, but there are still practical difficulties to overcome. The ordinary *taungya* cutter (shifting cultivation) works on a five-year period on five acres of land. The area afforested to 1939 amounted to 20,200 acres. The greater part of the plants used are raised in large permanent centralised nurseries; the accessibility of the forest areas, the large numbers of plants handled, the availability of lorry transport and the provision of ample funds make their maintenance practicable.

While to a British forest officer acquainted with tropical conditions some of this expenditure may be regarded as excessively extravagant, the chief lesson to be learnt is that when degradation and erosion of a region have reached a certain point, the costs of rehabilitation, where possible, are enormous.

Swabey mentioned that, generally speaking, the economy of the West Indies as a whole is based on four major factors, already described; and added that the statement required modification in the case of Trinidad.

Trinidad has not however escaped the erosion menace. A committee recently appointed (1940) by Sir Hubert Young, the Governor, has been considering the position of the cocoa estates. A modification of the existing scheme of subsidies to cocoa producers is suggested in order that greater emphasis may be laid on

rehabilitation of estates under a ten-year plan. It has been estimated that the total cost of replanting with heavy yielding trees of 100,000 acres, considered to be suitable for intensive cocoa production would come to $10,000,000. The Committee point out that the general tax payer could not be expected to find all this money, though apparently the owners are unable to undertake the work without some assistance from general revenue. It is also said that the area planted in cocoa on unsuitable land is put at 85,000 acres. From all accounts some parts of the Gold Coast cocoa area are in, or are reaching, a somewhat similar position.

The Trinidad Committee point out that it is a matter of urgency to check the deterioration of the industry. Exports have declined and years of low prices have supervened; thus proper cultural methods have been hampered. But, it is said, one of the outstanding explanations of the low yields recently obtained is the large proportion of "poor bearers" among the tree population. Does this mean dying trees? Assistance in various ways is suggested, all costing a money outlay.

The report states: "In Trinidad agriculture, soil erosion may be a more serious problem than generally supposed." It is not unlikely that it will be proved that erosion in one or more forms is one, if not the chief, of the causes of the decreasing productivity of the cocoa estates. Before this possible factor has been studied, expenditure on further reparation, by replanting possibly impoverished soils, would appear to be a waste of public money.

It is of interest to note that the Trinidad Conservator of Forests, in the Annual Forest Administration Report for 1938, adverting to the cocoa industry, wrote: "In the present depressed state of cocoa, landowners are renting out increasing areas of steep hillsides to agricultural peasants who grow field crops, such as maize, tomatoes, etc., thereon, under a system of shifting cultivation. These peasants prefer the highest, steepest and most inaccessible portions of the hillsides as the danger of loss of crops by petty larceny is thereby lessened. The abnormally high rainfall of 1938, coupled with the increase of clearings, was productive of erosion, flooding and landslides to an unusual degree and revealed

clearly the dangers of the existing situation. The problem is under investigation by the Lands Advisory Committee."

Presumably the lands above alluded to form part of the recent Committee's 85,000 acres of unsuitable land for cocoa.

The extract from the Conservator's Report might equally well have been written for several other Colonies, especially in Africa.

The chief factor, a direct result of the misuse of the land under the three types of usage—Forest, Agriculture and Grazing—is erosion. Most officials know this in one form or another. Land Advisory Committees, Soil Conservation Boards, Special Research Officers—all have been or are being appointed. Few would dispute their importance and usefulness. But they can only advise.

At a minimum, two decades have elapsed (four would probably be nearer correct) since the subject of desiccation in Africa began to be discussed as a problem to be considered.

But has it ever been squarely faced? The fact that there is not a Colony or Protectorate which has yet definitely determined the total area of forest of all categories—high forest and savannah—in proportion to total area of country, which should form the indispensable minimum for reservation, is witness to the fact that the direct bearing of the forest area upon erosion is not understood; although it appears to be dimly realised and grudgingly admitted that there is perhaps a case for the urgent necessity of further reservations.

The decision, treating British Africa as a whole, is a decision for one man. It is only an accident that the individual Colonies happen to be, for governing purposes, independent units. So far as the forests and erosion are concerned, the Country can only be regarded as a whole—especially that great stretch lying to the south of the Sahara and stretching away to the Sudan. And the decision to be made is an administrative one. If, as there are strong reasons for believing, the forests in the part of the African Continent here alluded to have already been reduced to a dangerously low level—a level under which erosion in various forms becomes an increasing menace, only strong administrative action with the object of checking such abuses as are inimical to the maintenance of all remaining existing forest can stay further depreciation and degradation.

It has been said that the subdivision of parts of British Africa into the several Protectorates or Colonies is a purely fortuitous one. Administratively, from the point of view of the welfare and prosperity of the people, erosion and desiccation is common to all, and is probably one of the most vital problems of the day. This, of course, applies with equal force to the rest of Africa outside British jurisdiction, for example, French Equatorial Africa and the Belgian Congo.

It may be suggested that the Secretary of State for the Colonies has never before had the opportunity now presented of discussing this matter with Colonial representatives of these two Powers. Such representatives, connected with Societies and so forth, of their respective Colonial Territories are now in London. The Royal African Society has already offered them the hospitality of its rooms and library.

A small International Committee appointed now to consider the general problem as it affects the greater part of the African Continent could lay down once and for all, and with an authority never before possible, the main lines to be adopted.

It is known that the French method of Civil Administration in Africa gives them a more or less free hand to acquire the land unquestionably necessary for State purposes, i.e., in the interests of the present and future prosperity of the peoples.

It may be suggested that if the ideas were now pooled while affairs in Africa, as elsewhere, are, so to speak, in the melting pot, a step could be taken which would lead to a settlement on the right lines of the most serious questions affecting the future welfare of the dark continent.

It is just when the flames of war are burning their fiercest that those responsible for the Civil Administration of the backward countries should, it is suggested, be throwing their thoughts ahead, and be considering in a spirit of cool inquiry, free from all pre-war ideas and convictions, the steps to be immediately taken when the battle fires have been quenched.

A unique opportunity has presented itself to obtain an international opinion, administrative and scientific, on this question, the gravest in Africa, of forests and erosion. Could it not be taken?

INDIAN FORESTER

AUGUST, 1941

DEMONSTRATION OF *JASSUS INDICUS* (WALK) AS A VECTOR OF THE SPIKE DISEASE OF SANDAL (*SANTALUM ALBUM*, LINN.)

BY RAO SAHIB S. RANGASWAMI, FOREST RESEARCH RANGER, DENKANIKOTA,

AND

A. L. GRIFFITH, M.A., M.SC., I.F.S., CENTRAL SILVICULTURIST.

Abstract.—In an experiment done at Javalagiri in North Salem District *Jassus indicus* (Walk) has been shown to be a vector of the spike disease of sandal (*Santalum album*, Linn.).

The experiment was done in July, 1940, and 50 per cent. of the plants in the cage developed the disease. The three criteria of spike were all present:

(*a*) The morphological symptoms of spike were transmitted to healthy plants by *Jassus indicus.*

(*b*) These symptoms thus produced were then transmitted to other healthy plants by means of leaf-grafting.

(*c*) The plants are progressing towards death and one plant has already died.

The experiment is still under observation and needs confirmation by repetition.

This note is a preliminary report of the experiment.

Introduction.—The experiment is one of a series on individual insect transmission done to test the insects already suspected as possible vectors from previous work. The list of suspected insects and the manner in which it was prepared were described in Indian Forest Records, Entomology, New Series, Vol. VI, No. 4, pages 109 to 114.

Locality.—The experiment was done at Javalagiri in North Salem Division by the research ranger, Denkanikota.

Description of Cage.—The cage used (No. 36) was made of wire mesh of 20 to the inch and was six by six by seven feet in size. The plants in the cage were kept raised on a bamboo platform inside the cage so that the tops of the plants should be near the roof

of the cage. This was done as in the mass infection cage experiments it was noticed that the insects appeared by day to have a preference for the top of the cage (1 page 102).

Plants in the cage.—(*a*) HEALTHY PLANTS.—Eight healthy two-year old plants in pots were put into the cage. These plants and their hosts were:

Plant No.	*Host plant.*
6255	*Acacia farnesiana.*
8158	*Acacia farnesiana.*
3115	*Mundulea suberosa.*
4465	*Mundulea suberosa.*
7575	*Mundulea suberosa.*
8457	*Mundulea suberosa.*
10170	*Mundulea suberosa.*
10375	*Mundulea suberosa.*

These plants had been taken from a two-year-old regeneration group under a mother tree in Noganur reserve forest in May to July, 1938 (2 page 28). They were healthy when dug up, and were taken to Denkanikota pot culture plot (a healthy area) and there stumped and grown in pots. The mere fact of stumping them would have forced out the disease symptoms had any existed at that time. They were put into the cage at the end of June. 1940, after a very careful examination for healthiness.

During this period from May to July, 1938, 2,100 plants were taken from these Noganur regeneration groups and not a single plant has shown any disease since. It thus appears that the healthiness of the stock used in this experiment was established.

(*b*) INFECTIVE MATERIAL.—The infective material in the cage during the experiment was plant No. 8320. This also came in 1938 from the same 1936 regeneration group in Noganur reserve forest. It was grown with a host of *Solanum seaforthium.* It had been grafted with diseased material and organic fusion had taken place, but it did not manifest the disease until after the conclusion of the experiment. It is now dead. This plant was thus in a state of disease-making throughout the experiment.

(*Note.*—A disease-masking plant was used as the infective material instead of a diseased plant owing to shortage of spiked plants.)

Insect releases.—Jassus indicus (Walk) was released into the cage as follows:

Date	*No. of insects released*
30.6.40	14
6.7.40	2
10.7.40	3
11.7.40	2
12.7.40	2
14.7.40	1
18.7.40	3
19.7.40	1
16.8.40	1
Total ...	29 in 9 releases.

Thus, the effective period of exposure was approximately from 30th June to 19th July, 1940, a comparatively short period, and as only 29 insects in all were released, results cannot be said to be due to mass feeding.

Removal and Identification of Dead Insects.—Dead insects were removed from the cage as follows:

2.7.40	2
3.7.40	1
4.7.40	1
6.7.40	2
10.7.40	1
12.7.40	3
14.7.40	2
15.7.40	1
18.7.40	1
19.7.40	1
30.7.40	1
31.7.40	2
	18

These insects were sent to the Forest Entomologist, Forest Research Institute, Dehra Dun, and 13 of them arrived in a condition fit to be identified. All 13 were identified as *Jassus indicus* Walk. Thus, although only slightly less than 50 per cent. of the insects used were check identified, there was no case of misidentification at all among them. The chance of misidentification of insects put into the cage, therefore, appears very small.

(Our thanks are due to the Forest Entomologist for his work of identification.)

It had been intended to release insects into the cage throughout August as well, but *Jassus indicus* did not appear in sufficient numbers in the insect collections of that month. The plants were removed from the cage and taken to the Denkanikota pot culture plot for observation on 15th October, 1940.

Appearance of Suspicious Spike-like Symptoms.—On 20th October, 1940, plant No. 10375 appeared to be suspicious owing to a peculiar tuft of leaves that had formed on the top of one of its twigs. On the 29th October, 1940, the suspicious symptoms were quite definite and another twig showed a suspicious tuft.

On 22nd October, 1940, all plants were given a top dressing of the soil and manured with sand, soil and farmyard manure. All hosts were healthy and this top dressing of the soil was done to prevent suspicious symptoms appearing due to ill health of the hosts (1 pages 124 and 125).

On 22nd October, 1940, the other seven plants were defoliated in order to determine whether any of them were masking suspicious symptoms.

On 14th November, 1940, plant No. 8457, on 2nd December, 1940, plant No. 8158 and on 4th December, 1940, plant No. 7575 developed suspicious symptoms. The other four plants remained healthy, plants Nos. 3115 and 6255 appearing particularly so.

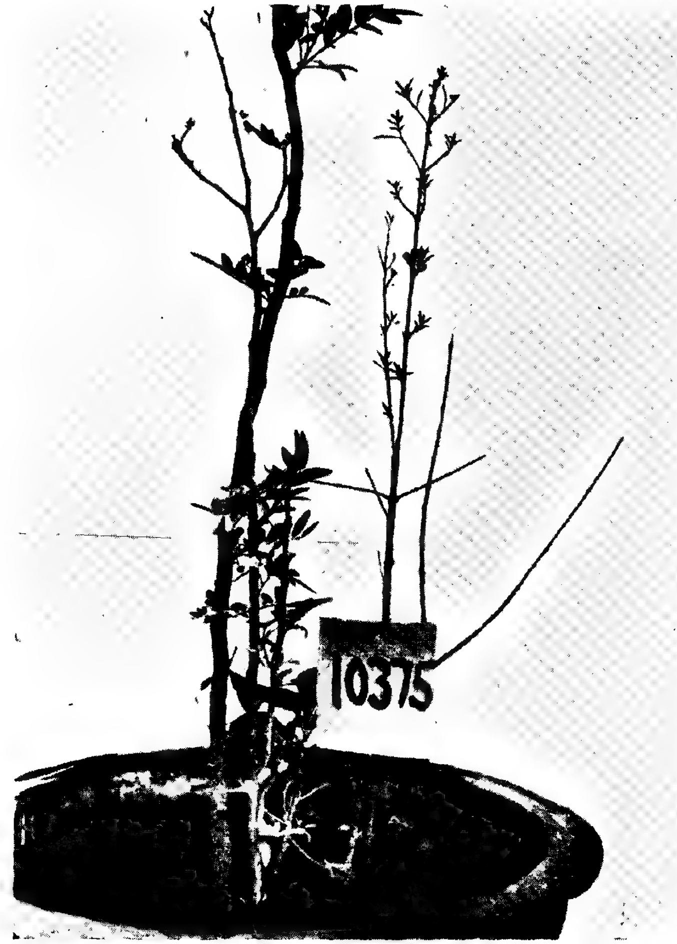
Grafting to Endeavour to Transmit the Suspicious Symptoms.—Grafting of suspicious material from these four suspicious plants to

Fig. I.

Plant No. 10375, the first plant in the cage to develop the disease. The symptoms first showed on 20-10-40. The photo was taken on 30-10-40.

Photo: S. Rangaswami.

Fig. II.



Plant No. 10375. The photo was taken on 28-3-41, *i.e.*, 5 months after the disease symptoms had appeared.

Photo: S. Rangaswami.

Fig. I.

On the left is plant No. 7575. This plant was defoliated on 22-10-40 and manifested the disease on 4-12-40. The photo was taken on 21-12-40.

Photo: S. Rangaswami.

Fig. II.

In the centre is Plant No. 7575. The photo was taken on 28-3-41, *i.e.*, nearly 4 months af.er the disease symptoms had been forced out by defoliation.

Photo: S. Rangaswami.

healthy plants was done as follows:

Date	No. of suspicious plant	Type of material used	No. of plant grafted	Remarks
14-11-40	10375	s	16295	
	10375	a. h.	16296	
30-11-40	10375	s	16295	
7-12-40	10375	s	16295	
	8158	s	16508	
23-12-40	8158	s	16511	
24-12-40	7575	s	16512	
	7575	s	16510	
17-1-41	7575	s	16513	
	8158	s	16514	
23-1-41	10375	a. h.	16296	
26-1-41	10375	a. h.	16296	
	10375	a. h.	16515	Manifested the symptoms on 28th April, 1941.
23-2-41	10375	a. h.	16515	
	7575	s	16516	
26-2-41	8158	s	16520	
	8158	s	16521	
	7575	s	16522	
8-3-41	8158	s	16523	
	7575	s	16524	
14-3-41	7575	s	16525	
	8158	s	16526	
22-3-41	7575	s	16527	
	7575	s	16528	
23-3-41	7575	s	16529	
	7575	s	16530	

s=*Suspicious material.*
a. h.—Apparently healthy material (*i.e.*, disease-masking).

So far, plant No. 16515 manifested the suspicious symptoms on 28th April, 1941, thus showing that these suspicious symptoms could be transmitted to a healthy plant by grafting. It is to be noticed that it had been grafted on 26th January, 1941 and 23rd February, 1941 with disease-masking material from plant No. 10375 and in both cases all grafts fused successfully. The season and material used with earlier grafts did not appear to be very good but it remains to be seen how these other grafted plants fare.

Discussion.—The criteria of spike have been taken to be three in number and all must be present before the phenomena resulting are accepted as spike (1 page 89).

These criteria are:

(*a*) The morphological symptoms as described.

(*b*) The symptoms must be capable of transmission to healthy plants by grafting.

(*c*) The death of the plant must occur within a reasonable period.

In the experiment described, the morphological symptoms appeared on four out of eight plants (i.e., 50 per cent). The plants are obviously progressing towards death as on 28th April, 1941, plant No. 8158 was dead, plant No. 8457 was still green but almost leafless, plant No. 10375 had a few very small leaves and plant No. 7575 had plenty of leaves although these were very small and narrow. As shown by plant No. 16515 in the paragraph above the symptoms were transmitted by grafting.

Conclusion.—We thus have all the three criteria of the disease present and can only conclude that we have demonstrated *Jassus indicus* (Walk) as a vector of the spike disease of *sandal.* The experiment, of course, needs confirmation by repetition.

Notes.—Several points of interest have arisen in the course of this investigation.

(*a*) *Month of Infection.*—The infection in the cage took place in early July. In (1) page 96 the main infective season was deduced to be mid-August to mid-November.

This very approximate period was, as stated, based on very limited data from exposures of one month, two months and occasionally three months, the longer periods being neglected. In these experiments the time of infection was taken to be the middle of the period of exposure whereas it might quite easily have occurred at any time during the period.

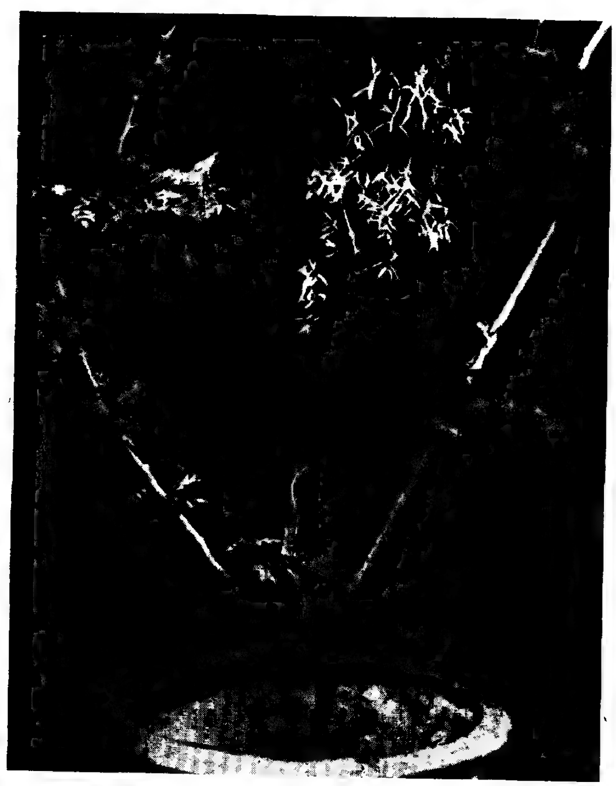
Thus the fact that in this present experiment transmission took place during the first three weeks of July does not in any way clash with the evidence already put forward on the main season of infection. In any case, the beginning and the end of the infection season probably vary from year to year and as we gather further evidence it is quite likely that we shall have to modify our early opinions,

Fig. I.

Plant No. 8158. The photo was taken on 21-12-40, *i.e.*, 3 weeks after the disease symptoms had been forced out by defoliation.

Photo: S. Rangaswami.

Fig. II.



Plant No. 8158. The photo was taken on 12-5-41. The plant was completely dead with all the leaves withered and dried but not yet fallen.

Photo: S. Rangaswami.

Fig. I.

On right, plant No. 16515 grafted with disease-masking material from Plant No. 10375 on 26-1-41 and on 23-2-41. The photo was taken on 28-3-41 after the grafts had fused but before manifestation had taken place.

Photo: S. Rangaswami.

Fig. II.

Plant No. 16515. This plant developed the disease symptoms on 28-4-41, showing that the suspicious symptoms of Plant No. 10375 could be transmitted by grafting and hence that it was a true case of spike. The photo was taken on 12-5-41.

Photo: S. Rangaswami.

(*b*) *Period of Infection to Manifestation.*—The infection took place in the cage between 30th June and 19th July, 1940 and from the table of insect releases it appears likely that it took place towards the beginning of the period. Manifestation took place on 29th October, 1940, i.e., the period from infection to manifestation was thus a maximum of 122 days and a minimum of 102 days.

This compares with the data for natural infection in the field which showed a minimum period of 64 days and an average period of 209 days (1 page 92).

The first plant in the mass infection cage experiments of 1934 (which experiments first demonstrated that the spike vector was an insect) took roughly 137 days from the probable date of infection to exhibit the disease symptoms.

(*c*) *Grafting.*—Plant No. 16515 was grafted on 26th January, 1941 and 23rd February, 1941, and showed the disease on 28th April, 1941, i.e., 91 days from the first set of grafts and 64 days from the second set of grafts. This compares with the data of a minimum period of 31 days and an average period of 138 days already put forward (1 page 92).

(*d*) *Period from Manifestation of the Disease to the Death of the Plant.*—One plant (No. 8158) is already dead. The period from manifestation of the disease to its death in this case comes normally within the data of a minimum period of 69 days and an average period of 264 days already put forward (1 page 93).

(*e*) *Previous Cases of Transmission of Suspicious Symptoms.*—In previous experiments suspicious symptoms were obtained with *Moonia albimaculata, Nezara viridula, Coccosterphus tuberculatus* and in two cases with *Jassus indicus* (1 pages 124 to 126).

In all these cases we were unable to transmit the suspicious symptoms to healthy plants and also, in time, the plants all returned to normal. The symptoms in the case of *Moonia albimaculata* were presumed to be due to the death of the host plants and the recovery of the plant was associated with the provision of new hosts and manured soil.

In the remaining cases it was speculated that spike is a complex virus and that we had transmitted some of the components of the complex.

The experiments with *Jassus indicus* were done in November, 1937 to January, 1938 (i.e., just after the main infective season) and January and February, 1938 (i.e., just before the secondary infective season).

(*f*) *Previous Experiments with Jassus indicus.*—In the previous three years, 10 experiments were done at Denkanikota centre and 12

at Javalagiri centre with *Jassus indicus* and this present experiment is the first in which transmission of the disease has taken place, though twice before we have transmitted suspicious symptoms that in turn could not be transmitted by grafting (1 page 125).

A scrutiny of these 22 experiments shows that this present experiment is the first in which the following conditions were all present:

(*i*) The cage was a large one (most experiments were done in three-foot cube cages).

(*ii*) The infective material in the cage was disease-masking and not diseased.

(*iii*) A reasonable number of insects were released at reasonably short intervals (1 page 121).

(*iv*) The experiment was done in the beginning of the main infection season.

The senior author handed over charge as Silviculturist, Madras, in the middle of December last. Since then Mr. Raghavan has been in charge of the technical aspect and observation of these plants and our best thanks are due to him.

The senior author as Central Silviculturist visited the experiments again in the end of January last.

This is merely a brief preliminary report of this experiment. When it has been concluded and confirmed by repetition it will be written up in full by the Silviculturist, Madras.

S. RANGASWAMI.
May 7th, 1941. A. L. GRIFFITH.

REFERENCES TO LITERATURE

(1) GRIFFITH, A. L. AND RANGASWAMI, S.—*Indian Forest Records—Entomology—(New Series)*, Vol. VI, No. 4.

(2) GRIFFITH, A. L.—*Annual Report on Silvicultural Research in the Madras Presidency*, 1934-1935.

[Since writing the above, in a further experiment done with *Jassus indicus* at Javalagiri in November and December, 1940, suspicious symptoms appeared in June, 1941, on 4 out of 7 plants that were in the cage (i.e., 57 per cent.). In this experiment also the source of infection in the cage was a disease-masking plant. Although, of course, further observation and tests are necessary before the plants can be pronounced as definitely spiked, yet the experiment appears to confirm the result discussed in this note that *Jassus indicus* is a vector of the spike disease of sandal.

The work of the past few years thus suggests that possibly disease-masking foliage is infective to the vector while spiked foliage has not this effect. Further intensive study of this aspect is indicated.]

SYNTHETIC TALL OIL

By T. P. Ghose and B. S. Varma, *Chemical Branch, F.R.I.*

Tall oil is the commercial name given to certain oily by-products obtained during chemical pulping of pinewood by the alkali-sulphate process. Pine in Swedish is called "Tall" and hence the trade name for the oily products. Pinewood, on account of its containing resins and terpenes which are difficult to eliminate entirely, was never considered a very suitable raw material for obtaining chemical pulp for the manufacture of paper. Since the development of the soda-sulphate process these difficulties have been overcome and chemical pulp is being manufactured from pinewood in very large quantities in the United States of America, Sweden, Finland and other countries.

Besides the usual constituents of wood, almost all conifers contain varying amounts of resinous and fatty matter and terpenes which, during the process of chemical pulping, undergo a variety of changes. The nature of these changes depends upon the pulping process and the conditions under which it is applied and results in yielding oily products of varying composition which are removed along with the waste liquors. The resins get converted into sodium resinates and fatty materials to sodium salts of fatty acids and glycerine but the terpenes remain unchanged and get removed during the blowing off of the steam; consequently, these do not find their way into the waste liquors. "About 15 years ago, a confidential questionnaire was circulated among American pulp and paper manufacturers questioning them on the best means for disposing of a troublesome frothy paste that seemed to settle out of pulp mill waste liquor, plugging pipeline and clogging equipment. The response concurred remarkably in the opinion that (1) the material was a nuisance, (2) the best way to be rid of it was to burn it up."—(Pollak, Oil & Soap 1940, 87.) Tall oil is derived from these waste liquors. The waste liquors are concentrated and, when cooled, the sodium resinate and sodium salt of fatty acids get precipitated in the form of soap. A little addition of sodium chloride helps the precipitation and coagulation of this soap which, in appearance, is dark-brown or almost black. Commercially this is known

as sulphate soap which, when treated with mineral acids, splits into resin acids and fatty acids forming a dark, disagreeable smelling oil known as "tall oil" or "liquid rosin." It is stated that in the manufacture of a ton of pulp 60 lbs. of tall oil is obtained. The crude oil can be purified mainly by distillation under vacuum, when a light-coloured oil of a not disagreeable odour is obtained. Below are given typical analyses of commercial samples of tall oil (*A. Pollak, loc. cit.*):

TALL OIL

Typical Analyses of Commercial Samples of Tall Oil

Description	*Acid value*	*Saponification value*	*Rosin acids*	*Fatty acids*	*Non-acid sterols*
			Per cent.	Per cent.	Per cent.
American crude ..	150—160	160—170	40—45	45—55	6—10
,, refined .	170—180	170—185	34 38	55—60	6—10
Danish crude ..	158—166	173—176	33	54—55	6—7
,, distilled ..	..	185	12	83	5
Finnish distilled ..	155	173	37	58	5
Swedish crude ..	163	170	44	..	9
,, distilled ..	186—189	..	12	82—83	5

Tall oil or liquid rosin is a comparatively new product and, during this short period, has already found many useful applications. For example, it is being used in the manufacture of certain qualities of soaps, froth flotation of oxide minerals such as phosphate rock, manganese ore, as cutting oil, as substitute for Turkey red oil, for softening and curing of rubber and in making asphalt emulsions of certain specifications. In fact its biggest consumption is in the manufacture of asphalt emulsions for road building since it is preferred to rosin and cheap fatty acids. Its most effective advantage is its low price and easy availability. It is stated that the United States of America produces nearly 20,000 tons per annum of liquid rosin (though her potential capacity is over 80,000 tons)

and an equal amount is being produced in Sweden. It finds markets all over the world because it is cheaper than any other organic acid available. In 1939, the price in bulk f.o.b. works U.S.A. was quoted at $30 a ton or about eight annas a gallon.

The crude liquid rosin (tall oil) consists of, on an average, 45 per cent. rosin, 45 per cent. fatty acids and 10 per cent. unsaponifiable matter. The constituents of fatty acids are oleic, linoleic, linolenic (about 5 per cent.) and palmitic acid (4—6 per cent.). The resin acid is mainly abietic acid.

In India the manufacture of pulp from pinewoods has not yet been started. Consequently this source of tall oil as a by-product is wholly absent but there are ample quantities of rosin and fatty oils available to serve as ingredients for the production of synthetic liquid rosin.

It is quite possible to make synthetic tall oil of given specification by suitable compounding of the ingredients but it is very doubtful if it can ever be produced at the staggeringly low price of eight annas a gallon.

The supply of foreign liquid rosin having been greatly reduced or cut off on account of the war, there is a considerable demand in this country for a product similar in quality and properties to the imported liquid rosin or tall oil. The question, therefore, was to obtain a suitable substitute for liquid rosin and the possibility of employing rosin oil as a base was considered. Rosin oil is being manufactured in India for a variety of purposes such as for axle grease, etc. This oily product of distillation is a complex material consisting of abietic acid in solution with complex terpene oils. It differs very materially from mere solutions of rosin in turpentine or other solvents in that on leaving rosin oil for a length of time no crystalline or amorphous abietic acid or rosin makes an appearance, whereas in the case of solutions of rosin crystals of abietic acid are deposited after some time. Rosin oils prepared by distillation of rosin ordinarily possess low acid value (40—70) and saponification value and even though they are excellent emulsifying agents they are not suited for the manufacture of asphaltic road emulsions which require rosin oils of acid value of about 150 and saponification value of about 165. As has been stated above, rosin

oils obtained by distillation of rosin are low in acidic constituents, much of the acid radical being split off. This is so if, as is ordinarily the case, the distillation is conducted at atmospheric pressure and at a slow rate, thereby allowing a fuller decomposition of rosin to take place and a larger proportion of it to be converted into pitch. If, on the other hand, distillation is conducted at reduced pressure or at higher speed, the resulting oils contain a higher percentage of abietic acid and, consequently, possess higher (90—105) acid and saponification values. Even this acid value of rosin oil is not high enough for asphaltic emulsions and hence arises the necessity of compounding such a rosin oil with suitable proportions of fatty acids to make the mixture match with "tall oil." Tall oil, being essentially a mixture of about 45 per cent. rosin acids and 45 per cent. of fatty acids, a synthetic tall oil of correct specification can be obtained if rosin oil, obtained by distillation of rosin at a fast speed or under reduced pressure, is mixed with suitable proportions of fatty acids.

Fatty acids may be obtained easily by saponification of any fatty oil with alkali but as the constituents of the fatty acids of tall oil are mainly oleic and linoleic, the choice of fatty oils is restricted. Those that are rich in oleic, linoleic, ricinoleic and the like acids of high acid values may be employed, keeping an eye on the price of the oil.

Synthetic tall oil, though an excellent substitute, can never compete with the purified tall oil of commerce in prices. Tall oil, as has been stated above, is a by-product of an extensive industry whereas the synthetic substitute has to be prepared from individual ingredients which are already products of trade and are, therefore, more expensive. But when the supply of original commercial product, i.e., tall oil, has been cut short by war and its prices have risen considerably in this country, the synthetic product may compete with it and flourish during the period of the war. Since the initial cost of equipment required for its manufacture is low, it is recommended to prospective manufacturers.

TREATMENT OF TEAK PLANTATIONS

By T. K. Mirchandani

Teak occurs naturally in mixed woods in groups, the average stocking varying from nil to about thirty per cent. of the crop. In teak-bearing areas it is the principal species that brings in revenue from these forests. Therefore, its replacement by young crop is obviously most important. Natural regeneration of teak is found but rarely, and no sure and reliable silvicultural method of obtaining it has yet been discovered. Fortunately, its artificial propagation has reached the stage of mass production. Given the requisite rainfall, artificial regeneration of teak by root and shoot cuttings, popularly called "stump planting," is now almost foolproof. One hundred per cent. successful stocking by this method is a common occurrence. By this method thousands of acres of teak plantations are being raised in all teak-bearing areas of Central, West and South India and Burma.

Proper treatment of these plantations, therefore, requires careful consideration.

It is well known that teak is a very strong light demander and also that it is intolerant of crown friction. The result of this is that pure teak crop will not maintain a closed canopy except in the early stages of its life, i.e., in sapling and young-pole stage.

Being a species which is very quickly decidous, it drops all foliage early in the dry weather and, for nearly six to seven months in the year, the forest floor in teak plantations is exposed to burning sun and winds. This exposure, besides rendering the teak plantations predisposed to intense ground fires must, by itself, adversely affect the factors of the locality and materially reduce the moisture contents of the soil.

The natural solution is to imitate Nature and grow mixed woods. This is not practicable directly as, in a mixed teak and other species plantation, there is always the problem of other species suppressing teak, thus complicating thinnings. Also teak, being intolerant of shade and crown friction, further complicates the problem. Such mixed plantations, due to a bias in favour of teak, merely result in the other species being annihilated in the first two

or three thinnings, leaving a pure teak crop. This is a wasteful method and adds to the costs of formation without achieving the object of obtaining mixed woods.

Another solution is to gradually tend the pure teak plantations into mixed woods of the desired predetermined percentage of teak in the mixture. It is this solution that is discussed in the following paragraphs.

In order to elucidate my suggestions, let me take a practical example and apply the solution to it. Suppose in a certain locality for a given quality class rotation of teak has been fixed, say, at 135 years. In this period the teak is calculated to reach the commercially exploitable diameter of, say, 30 inches at breast height. The forest is worked under a method of selective fellings confined to teak and other commercially important associates of teak. Teak in such a case being responsible for nearly 90 per cent. of the gross revenue, is being replaced by artificial pure teak plantations in selected areas.

Such a plantation would be given the following treatment:

Rotation 135 years	*Treatment*	*Interval between Thinnings*	*Remarks*
Years			
0 ..	Plantation ..	..	Initial spacing six by six feet.
5 ..	I Thinning ..	5 years	
10 ..	II Thinning ..	5 years	
20 ..	III Thinning ..	10 years	
35 ..	IV Thinning ..	15 years	
55 ..	V Thinning ..	20 years	
75 onwards ..	Selection marking in teak and other commercially exploitable associates of teak.		

The time interval between two thinnings depends on the quality-class and age of the crop. The richer the soil, the better the response would there be to the opening of the canopy and, therefore, the shorter the interval between successive thinnings. Also,

the younger the crop, the faster the rate of growth, and, therefore, the shorter the interval between the thinnings.

The first two thinnings would be more or less mechanical and would involve the removal of at least 50 per cent. of the standing stems each time. Further thinnings will be silvicultural, more attention being paid to the crown requirements of each individual tree and its own form than to mere even spacing of stems as in the case of first and second thinnings. The heavy opening of the canopy at the time of the I and II thinnings would induce natural regeneration of associates of teak partly by coppice and partly by seedling regeneration from seed already present and also from adjoining mixed woods. In the III and subsequent thinnings each tree will be examined on its merits. Its removal or the removal of the adjoining tree will be decided on the principle of survival of the soundest stems and provision of sufficient crown space for such stems. From the III thinning onwards the natural regeneration of the associates of teak will not be cut back drastically as at the time of the I and II thinnings, but it will be nursed only to the extent that it does not compete with teak by the time of the next thinning.

Thinnings as such will cease by the end of the first half of the rotation. If thinnings are properly carried out, the pure teak plantation will, from now onwards, tend to merge into a mixed teak forest. Except that in this case the percentage of teak will be higher than in natural teak forest up to 50 per cent. of the dominant stems and *all* teak trees will be in the dominant or co-dominant class and will also be as sound as the local soil and seed sown are capable of producing.

In order to progressively obtain and maintain the natural regeneration of important associates of teak strict fire protection in the first half of the rotation is very necessary. Teak is one of the most fire-resisting species, but the majority of its commercially important associates are fire-tender. In fact, in order to convert a mixed teak forest into a poor quality pure teakwood forest, one has merely to burn it from year to year and see the percentage of teak rise and its quality deteriorate.

Hereafter the former pure teak plantation, which has now reached the stage of a mixed teak forest with a preponderance of

teak trees, should be treated like mixed wood. All exploitation hereafter shall be purely selective. Sound associates of teak shall not be sacrificed for a badly formed teak. Only stems which have reached exploitable diameter will be removed in order to obtain the yield from that compartment as calculated by any one of the—for the time being—accepted formulæ. It is immaterial whether the formula is safeguarded or not provided the teak plantations are raised from year to year.

Mixed teak forests on poorer soils, popularly called Teak Pole Areas, may also receive similar treatment. Most of such areas, on account of purely revenue considerations, are worked under a clear-felling system with artificial regeneration of teak in selected patches of the clear-felled coupes. Here also the patches should be treated individually for the first half of the rotation and thereafter these will merge into the compartment in which they are located and receive compartment treatment like the rest of the adjoining crop.

Incidentally, even such forests, when located in close proximity to large towns, should not be clear-felled on account of climatic and æsthetic considerations. They should be worked under a selective exploitation treatment usually given to High Forests; a few patches being clear-felled and planted with teak in order to maintain the financial yield of these partially preserved areas.

It will be seen from the foregoing that pure teak forest as such ceases to exist after the first half of the rotation. If the sites and soil for the plantations are properly selected, the intermediate yields during the first half of the rotation will have more than paid the initial costs of formation and interest accumulations thereon. In addition, we have converted a comparatively inferior mixed teak forest into a high value mixed teak forest and, at the same time, maintained the factors of the locality at an optimum point.

Teak yield tables per acre of the final crop after the first half of the rotation have very little practical value. Because an acre of pure teak forest with normal stocking and a closed canopy at an advanced age does not exist except under most artificial conditions. Individual stem volume tables would still be useful for estimating yield from individual trees.

EXTRACTS

USING WOOD WASTE

By A. Powis Bale, A.M.I.MECH.E.

The chief problem of wood waste is its marketing rather than its production. Firms producing wood waste have usually to find channels for distribution quite different from those taking the normal products of the firm. And, further, as the wood waste is an incidental by-product, it varies considerably in quantity and variety. It is obvious, too, that the difficulties of the small wood waste producer are much greater than those of the big firm, and there is ample scope for setting up a central organisation to collect, classify and distribute the material to users.

At present large quantities of wood waste are being burnt in an entirely uneconomic way in open fires, unsuitable boilers, etc., but such practice will naturally pass with improved plant. There is considerable difference between the output of a special furnace and

an ordinary boiler. A wood-working factory burning shavings in conjunction with coal raised 2 lbs. of steam per 1 lb. of shaving; but when a special furnace was installed 5 lbs. of steam was raised for the same amount of wood waste. While wood-working factories have usually brought their machinery up to a high standard of perfection, in many cases they still regard wood waste as something to be disposed of anyhow rather than as, for one thing, a valuable fuel. Efficient installations necessitate special furnace construction and refractories—a fact not generally appreciated.

While furnaces that burn wood waste in suspension are capable of high efficiency, they are suitable only for large installations on account of the rather expensive plant necessary. For smaller plants, furnaces having the grate tilted at an angle are most suitable. These must be capable of burning coal satisfactorily for starting up and possibly for week-end periods. An example of the savings to be effected by the installation of appropriate plant is furnished by the British Brush Co. at Wymondham. This firm originally spent annually £300 on electricity and £400 on gas and coke. By the use of improved wood-burning furnaces and boilers not only has this cost been cut out but a substantial addition has been made to the electric power available. The cost of the current available is approximately .355d. per kw. hour. The wood waste available consists of blocks, pole ends, shavings and sawdust and amounts to approximately 70 tons per week. The boilers were installed by Ruston and Hornsby, Ltd.

Hardwood waste is chiefly used for destructive distillation and the process consists of two general stages—carbonisation and distillation. For the carbonisation process, the wood is heated in closed retorts and yields charcoal and crude pyroligneous acid. In the distillation stage the crude acid is split up into acetic acid, crude methanol and wood tar. While wood distillation is quite a common process nowadays there are few plants operating on wood waste and none so complete as the Ford plant at Iron Mountain in Michigan. Approximately 400 tons of scrap wood are produced per day at the sawmill and body plant of the Ford Motor Company. The scrap comes from the sawmill in the form of slabs and edgings and from the body plant as the trimmings. It comprises mainly maple,

birch and a small quantity of ash, elm and oak and the whole is of mixed moisture content. Destructive distillation was considered the best means of utilising this waste material and the plant to handle it is designed for continuous operation with automatic control and mechanical handling of materials. The plant is housed in two buildings containing the departments related, respectively, to carbonisation and distillation. The carbonisation building contains the wood-drying retort and charcoal departments, while the distillation building contains the primary separation, refining, direct ethyl acetate and pitch departments.

The wood scrap is carried by belt conveyors to a disintegrator which reduces it to pieces varying in size from that of a match up to eight inches by two inches by $\frac{3}{4}$ inch. From this it passes on another conveyor to storage bins in the carbonisation building. The sawdust and shavings from the saw-mill and body plant are handled independently of the scrap wood. The prepared scrap wood from storage goes to six rotary driers 10 feet in diameter and 100 feet long. These driers are heated by flue gas from the power house entering at 600°F. and blowing countercurrent to the wood. Each drier has a capacity of three tons of wood per hour and takes three hours to dry wood to an average moisture content of .5 per cent. Wood is discharged from the driers at a temperature of approximately 302°F., and is carried up an inclined belt conveyor to the top floor where the conveyor discharges over a magnetic separator for the purpose of removing scrap iron from the wood. The wood is discharged into a hopper from which it is diverted into chutes leading to the retorts. The direct products from the retorts are charcoal, which is removed through the barrel valve at the bottom of each unit and is sent to coolers and conditioners: pyroligneous acid or "green liquor," which is pumped from the condensers to the primary separation department; and non-condensable gas, which is passed through scrubbers and is blown over to the power house and burned under the boilers, as well as being used for heating up retorts. The charcoal from each conditioner may be disposed of in three ways, depending upon economic conditions. The bulk of it is generally pulverised and made into briquettes for sale outside of the company; any material not required for briquette production is

separated into graded charcoal; and any excess material is pulverised and burned under the boilers of the power plant.

Although certain grades of wood flour are readily made by the use of mills, the manufacture of wood flour for the plastics industry demands not only an elaborate plant, but also scientific control, and wood specially selected and graded. For this reason, it will be advisable to rule out this section as one of the uses of wood waste. For certain kinds of linoleum, wood flour has advantages over cork; and while it is difficult to ascertain the amount used by the English industry because of the secrecy the trade maintains over its operations, the U.S.A. uses some 10,000 tons of wood flour per annum. The light, fluffy nature of wood flour makes it quite suitable as a filling constituent in linoleum. It is mixed with cementing materials, consisting chiefly of resin, linseed oil and *kauri* gum. Rather coarse wood flour, properly called "wood meal," is largely used for certain composite moulded articles such as furniture, ornaments, mouldings, toys, knobs and similar articles. Unlike the very fine grades of wood flour, the meal is easily manufactured, the colour of wood being the most important factor. A machine particularly suitable for this purpose is the "Miracle" hammer-mill.

The grinding elements are composed of a battery of loose-swinging hammers held in position by bolts carried on discs which are assembled on the mill shaft. When the mill is in operation, the hammers stand out to their full extent on the bolts and are held there by centrifugal force, shattering in mid-air the material under treatment. This mill sieves while grinding. No outside dressers, therefore, are required. The lower half of the grinding chamber is fitted with a semi-circular, heavy, perforated steel screen. No actual grinding is done on it, as the tips of the hammers, when fully extended, are always at least half an inch clear of the surface of the screen, which simply acts as a dresser. The mill will produce almost any degree of fineness required, in one operation, by simply inserting a suitable screen. Precise control of the type of wood used is not so important in the production of building and insulating board as in many other uses. At one end of the range is the sound or insulating board, which is very coarse in grain: in some types, chips akin to wood wool are incorporated in the material. At

the other end are the hard boards that are practically synthetic hardwood panels which can be stained and polished or supplied tinted as desired. The bulk of this largely increasing market calls for the midway products.

While a little has been done in this country in the production of household fuel from wood, it has been left to the U.S.A. to introduce a practical and competitive wood log made from wood waste. This product, called the "Prestolog," is claimed to possess a heating value equal to soft coal. The wood used is dry sawdust or waste wood reduced to a similar condition by means of a mill or disintegrator. No binder is required—simply high compression applied through a special machine. The capacity of the machine is 10 tons each 24 hours, each log being 8 lb. in weight. Wood, being cellular in structure, is rather elastic and this makes compressing of more than a small quantity at a time very difficult when it is desired that it should remain so when released from pressure.

While the finer grades of wood wool demand the use of specially selected wood for their manufacture, almost any short ends of soft wood can be used for the coarser grades such as are used for general and hardware packing. The machine used for the production of wood wool is fitted with single, double and quadruple blades which are usually set in pairs. A plain knife like a plane iron is followed by one grooved according to the width of the wood wool desired; alternatively scribing knives held in a frame close together, or with spacers for the wider wool, can be used on some machines. The wood is held in self-feeding clamps, the feed being adjustable to give any desired thickness to the wood wool.—*Wood*, February, 1941.

WHAT ARE WE AFTER?

By Tom Gill

The title I have selected may have the virtue of helping clear our thinking about forest education, especially the phase of it we call public education. It forces us to think of the job before us in terms of "What do we want the public to do? Just what response are we after?"

For if we think of public education in forestry as directed toward some desired action on the part of the public, action which may or may not result in legislation, I think we have a useful standard for measuring our effectiveness. We have a clear-cut goal; a goal that can be defined in purposeful terms, and maybe we have something more. We have a tool to keep our efforts from getting hopelessly diffused, to keep us away from time and effort in random activities, and at any moment we choose to take stock we could tell whether we have succeeded or failed in that particular effort.

One of the reasons, it seems to me, why we do diffuse our efforts arises from the very wealth of techniques we have at our command. You know them all—the news item, the article, radio, lectures, posters, popular books on forestry—many, many techniques to bring the message to the general public. That's pretty elemental, and I would feel like apologizing for mentioning them were it not for a frequently ignored distinction that cuts across these techniques and forces you to depend on some of them to the exclusion of others. I mean the distinction between your proposed audiences.

What sort of audience are you aiming for? What kind of people are you depending on to put your programme across? If you don't know, you haven't thought through your problem. Sometimes the choice isn't difficult, as when you're confronted with the simple alternative between using a shot-gun or a rifle, depending on whether you're out to bag a widespread or specialized audience.

Widespread general audiences are the easiest to approach. But the mental level of such groups limits their usefulness, and they require an unbelievable amount of sugar on the pill. They offer the advantage of being reached in greatest numbers, and at lowest unit expense of money and effort; they are the natural target of the news-item-poster sort of thing. But they are a relatively ineffective group except on a long-time basis and except for problems that can be highly dramatized.

Your specialized audiences, on the other hand, are usually—not always, but usually—more adult; there are not so many of them, and your unit costs in time and energy are higher. But when you do get them, you've got something. For these are often the potential leaders in their communities, the ones most likely to effect the things we foresters want to bring to pass. These groups may be reached

by modifications of the usual techniques, by talks, by articles in specialized magazines. If the group is already organized, it may best be reached through its own organization channels. These smaller audiences of high potential power have been largely forgotten men among those of us who are engaged in educational work. They are harder to reach. Writing for them is more difficult, and the task of popularizing forestry for them is a vastly more arduous task. Unless they are pretty closely evaluated, there is danger of losing them either through too technical verbiage, or through the danger of over-simplifying your problem.

That's the ever-present danger in all jobs of popularizing forestry, and popularizing forestry when it is done honestly is certainly not duck soup from any rational viewpoint. The irony of it is that the better the job is done, the easier it looks. That may be why I always feel moved to speak a humble word for the men who are doing service in that difficult and none-too-well-understood field. These are the men we have to rely on to translate the work, the aims, the goals of forestry, not only into terms that the layman understands, but into terms that attract his attention, sustain his interest, and best of all enlist his support.

That's the job of the popularizer. Among foresters he is looked on all too often with the same easy tolerance that many professional writers reserve for the authors of juvenile fiction. Well, I can't feel that way, because for the past twenty years I have been labouring very close to that field, and each year I become more deeply impressed with its difficulties and with the inescapable fact that not one of us is quite equal to the task or to the challenge of its possibilities.

What do we need then to get the job done better? Well, we don't need new techniques—new avenues of reaching the problem. We have plenty of these, and they're becoming increasingly abundant. But one of the things we need is a better appraisal of the problem itself. Breaking it down into its simpler components; deciding just what components are most amenable to attack, what are the best agencies to use, and from what particular audience can we expect results, to know in a word just exactly what we are after.

There's just one further step I'd like to outline, and then I'm done. It has to do with team-work. In attacking every major problem that confronts us, a little teamwork wouldn't be bad. For a long time now I've had a dream that some day the leaders of educational work in forestry—federal, state, and private—might gather around a table, and there in the light of our many diverse viewpoints, we might at last define major goals.

It was a plan similar to this the Charles Lathrop Pack Forestry Foundation adopted when it tried to answer the question, "What shall we do to get the most effective results in forest education? Their answer was the creation of an advisory board made up of foresters in many fields, covering the country geographically. The job of these foresters was to arrive at an agreement regarding the things most needed to be done, and it has been on their recommendations that the foundation selects its projects.

I've often wondered what would happen if we tried this plan on a scale that included all the educational agencies in the field of forestry. I can't help believing that to-day there must be a staggering amount of overlapping effort, wire-crossing, and even conflicting activities. But once we know what we really want to do, it would not be so very difficult to decide on the best means of doing it, the people we want to reach—and then we could make a division of responsibility. No one organization is big enough to do it all—none too small to add to its effectiveness. Neither is it always a case of the amount of money available for the campaign. Even the men of the federal services are confronted with problems they can't even attack. It takes a private organization to do certain things that we all believe necessary, but which are clearly impossible under the federal set-up.

Just maybe when we come to look at our task of public forest education from such a vantage point, we shall see where some of our biggest holes are, and the reason for those holes. And then—and not one second before then—we will know where to start plugging. —*Journal of Forestry*, Vol. 39, No. 2, dated February, 1941.

FORTY YEARS OF PRIVATE FOREST OWNERSHIP

BY JOHN B. WOODS

So far as I am able to ascertain, there is to-day no single, overall federal forestry policy sufficiently authoritative and broad to serve as a guide for all administrative agencies of the government. Naturally enough, there is no single policy controlling state forestry; there may be as many policies as there are sovereign states, or more, or fewer. Perhaps the Joint Congressional Committee on Forestry will supply Congress with material for a master federal policy, which also will afford protection and opportunity to state and private forestry. I hope so, for they need the right kind of leadership and assistance. But my purpose is not so much to criticize Uncle Sam or the states as to suggest that private forest owners and operators are not alone in their failure to exhibit a unified forestry policy as a *fait accompli*. We all have been more or less wandering in the dark together.

Forty years is a long time, even though it has passed all too quickly for many of us here. It is long enough to reach back beyond the beginnings of most commercial forestry enterprises in this country, regardless of what those beginnings may have been. Back in 1900, private forest ownership ran more heavily to large holdings than it does to-day. There still were big sawmills in the East; South-eastern pineries were swinging increasingly into production; and Lake States lumbermen, nearing the end of their white pine supply, were preparing to move into the Gulf States or looking over the high hump toward the Pacific North-west. Railroads were finding their ways into the deep woods, and steam skidding machinery was being tested and made ready for a deplorable era of forest devastation.

Of the hundreds of important companies engaged in manufacturing lumber and other forest products, most had definite operating and financial policies. Practically all these operating policies regarded timber as a raw material in storage and ignored forest cropping as being quite beyond reason. Mature timber was too plentiful and cheap to permit growing future crops once the original crop should be harvested. A few curious men in the forest industries were sufficiently impressed by the conservation propaganda of that day to ask Uncle Sam's foresters to examine their

timber tracts and recommend forest management programs. So far as I know, none of these programs was seriously considered as a plan of action until long after the original investigation was completed; or, in other words, until the whole picture of American forests had changed.

It is my opinion, based upon some observation of conditions in the South, that the first awakening of forest owners to a possibility of growing trees at a profit resulted from the imposition by Uncle Sam of a General Forest Industries Questionnaire, in 1919. In order to learn enough about their holdings to satisfy the tax collector, or more exactly, the timber valuation engineer, private owners studied their cutovers and second-growth stands, and learned that timber grows; that mature trees are young ones grown up.

Development of conscious forestry policies by important industry units has been noticeable since the early 1920's. In general, it may be said to have come from increasing recognition of a few simple facts by forest owners. Trees reproduce; when released from competition of larger individuals, the smaller usually grow at increased rates; young growth, when protected from fire, tends to put on better wood faster than when subjected to periodic scorching. Other facts enter the picture. Old growth supplies retreated far from consuming centres and transport cost differentials became so great as to create usable values in young timber near at hand. The drying up of settler demand for mediocre land compelled owners of cutovers to refocus upon other potentialities of such areas.

No wonder, then that landowners in the East, Lake States and particularly in the great southern region, moved toward timber cropping. Usually the first step was to hang on to regrowing areas and then to recut here and there as soon as trees in workable numbers reached usable size. Eventually one owner after another came to visualize the possibility of prolonging his operation to something approaching permanency. At some point along the way, certain landowners grasped the fact that the harvesting process is susceptible of refinements vitally affecting future as well as present realization values. Thus, after some years, we find widely varying application of forestry science, but the net result is progress.

Less spectacularly, the non-manufacturing forest owner also has wakened to his opportunities to handle forest land as a plant for

growing wood to sell to manufacturers. If he is small and harassed by financial worries, the change comes hard; usually some aid must be given him. Last but not least in point of significance, in the virgin timber regions, large owners, with many years' supplies of standing trees, face the challenge of permanent operation as a necessary method of realizing upon their investments.

It is natural to ask: What does this add up to in terms of national annual production? To what extent does it guarantee an adequate future timber supply? One may guess that no more than half the timber now being cut for commercial use is harvested according to conscious plans to save reproduction or to assure prompt restocking. The percentage is increasing, but whether the rate of increase is rapid enough to satisfy us as foresters, is open to argument. My aim here is to review the significant facts about private forestry, inquiring how private owners and operators are thinking, and acting, and why, as a basis of planning for progress along lines most likely to lead toward success.

Forest protection always has been a neglected task. Insects and disease have ravaged our mature stands without much effective opposition from man. In recent years, the federal government has diverted considerable sums of relief money into control projects; but Congress never yet has been willing to come to grips with the problem. There have been examples of large-scale, courageous private insect control efforts, such as the western pine beetle cotrol work in Oregon, lasting more than fifteen years, and periodic forays against the hemlock looper in Washington. There have been others, with which I am less familiar. Some states have helped with permissive legislation, others with continuing appropriations, as in the New England programs. In general, private owners have looked upon such problems as being beyond their power to solve. Yet they must be solved somehow.

In fire protection, the story is somewhat different. It also is interesting and significant, indicating that the public must be a partner in forestry to make it go. Oldtimers say that the Lake States, around the turn of the century, were utterly defenseless against forest fires. The public in the cities did not care, and the forest dwellers could not help themselves. So forestry was kept back ten or twenty years by county-wide burnings. In the South,

where fires rarely were fatal to anything but small trees and vermin, repeated burning was long a part of traditional land use. In certain operations where fire was a menace, controlled burning was practised. But as forest owners came to understand that repeated ground fires, which killed reproduction, damaged timber quality and retarded growth, actually robbed them of realizable values, they began to move rapidly toward systematic fire prevention.

Out in the Far West, groups of private forest owners pioneered in organization of regular patrols. They secured legislation in most of the important timber states, making support of such activities compulsory upon all forest owners. They set out to protect virgin reserves and in time extended such protection to reforesting lands. The cost of patrolling non-operative areas was borne largely by owners; active operations were afforded special protection at the operators' expense. Gradually the states and the federal government picked up part of the burden, although even to-day the public contribution, including the highly valuable C.C.C. work, amounts to less than one-half of the annual fire-fighting expenditure.

Effective protection of reforesting lands can be accomplished in any region only when the general public awakens to its importance and not only demands it, but accepts a proper share of the cost burden. Overall fire defense progresses in some states and lags in others, according to the strength of public opinion. Looking into the matter of policies and recognizing that protection from fire is essential to forestry, we find that private ownership has provided a considerable measure of leadership along well-defined lines. But as the scope of such work broadens, private policy tends to look toward and merge into public policy because of the growing belief that this work is properly a function of local government.

The American tendency to organize for action is evident in the forest industries. There have been regional lumber trade associations and group agencies representing other forest products for many years. Their objectives have been concerned rather largely with production and distribution. Yet from time to time they have been constrained to wrestle with the cutover land problem. For example, twenty years ago the Southern Pine Association was promoting a livestock industry for pine cutovers. A few years later, the Western Pine Association began to formulate a forestry policy

applicable to the far-flung ownership of its members. And in response to the National Industrial Recovery Act, all the regional lumber trade associations accepted forestry functions as part of their responsibilities.

During most of their existence, these lumber trade associations have represented numerical minorities of producers in each region. For a year under the N.I.R.A., the associations, which were designated Code Agencies, were fully representative, under the law, of all producers of goods recognized as being covered by the Lumber Code. But even then, wood pulp, posts, poles, hewn ties, and some other products were not included. And although producers under that code did represent practically all lumber manufacture, and a significant portion of forest ownership, that condition did not last long enough to permit forest practice regulation to penetrate to the thousands of small holdings not directly tied to manufacturing operations.

The experience of 1934-35 had very great value, in that it highlighted some of the possibilities of moderate harvesting control. It also disclosed certain fundamental difficulties. The forest ownership pattern was shown to be wonderously complex, too complex, in fact, to respond quickly to voluntary self-regulation. The manufacturing establishment was found to be influenced by a responsible element, composed of the larger producers, representing from two-thirds to four-fifths of normal output in the several regions. These manufacturers were accustomed to association membership and joint effort in many directions. They approved a post-code commitment to continue their efforts to improve forestry applications to their operations. But this responsible element frequently is harassed, in its highly competitive field, by a numerically superior force of marginal operators who subscribe to no commitments, support no trade associations, and "wear no man's collar," not even their own. Self-regulation in harvesting practices means something quite different from conscious forestry to most of these thousands of smaller competitors.

Often it is urged that some overall association of forest owners should be set up to give effective representation and two-way flow of thought and guidance. Such an agency might, it is alleged, serve all landowners who have forests, and the general public as well, in

much the same way as the associated paper, pulp and pulpwood groups or the National Lumber Manufacturers' Association serve their membership and the public, in their respective fields. Perhaps such an organization could be built by the steps of local grouping and national federation, but inertia of numbers and the wide variation in kind and size of ownerships make it doubtful.

Undoubtedly the work done by these overall agencies is of great value, particularly where developments national in scope are concerned. We know that remarkable progress has been made in a few years by the paper, pulp, and pulpwood associations in promoting excellent forest management upon members' lands and in spreading the gospel of forest cropping among small landowners. And they have functioned articulately in presenting the case of private initiative to legislative and executive bodies. Similarly, the National Lumber Manufacturers' Association has helped fashion industry forestry policies while serving as a clearing house for member associations and as liaison with government. Its forestry division is staffed to continue and extend such services. Unfortunately, its sphere of influence and authoritative representation is limited to affiliated associations and their members.

Private forestry policy in 1940 is dominated by a widely held and growing belief that fire protection is necessary. The forest owner expects to bear part of the cost, but he insists also that other local taxpayers and the general public shall help. He considers the principle of federal co-operation embodied in the Clarke-McNary Act to be sound and satisfactory, and desires that it be adequately implemented with appropriations and extended to give protection against insects and disease. He does not consider that Uncle Sam has been victimized by this Act in the years since 1924, nor that the large owner has been benefited more than the small.

Beyond this point such policy is confused. The ownership pattern has changed notably since 1900. To-day more than half the commercial forest area is in holdings of less than 1,000 acres; in the United States there are only about 1,700 ownerships of more than 5,000 acres each. Forest owners number four to five millions, the great majority being farmers. These owners would like to derive substantial returns from such ownership. Most of those who own

small areas have had neither financial leeway nor technical knowledge to apply even rudimentary forestry practices. Presumably, certain groups can be reached by federal programs carrying benefit payments wrapped about forest improvement requirements; others can be helped by simple educational extension, if made available to them, and if market conditions continue to improve. State legislatures have it in their power, when local public opinion becomes sufficiently demanding, to subject all forest owners to reasonable harvesting requirements, designed to stop devastation, safeguard advance growth and provide for restocking. Such simple regulation, suited to local conditions will mesh neatly with public programs of education and co-operative protection.

It will reach also the thousands of small saw-mill operators, who usually subsist on hand-to-mouth timber purchases and run their shows without benefit of trade associations or industry forestry programs. In general, their policy is to cut down and saw up everything that will make saleable boards, and to let posterity do its own worrying about timber supplies.

About a thousand lumber manufacturers constitute the membership of the associations which have undertaken to promote forestry. They produce possibly three-fourths of the normal lumber output, and together with the paper and pulp groups, own or control the major portion of private forests now remaining in large ownerships. It would be misleading to declare that there is unanimity of opinion among them regarding the need for immediate recourse to state regulation. Yet their leadership points in that direction. In the more important producing regions, efforts to secure enactment of suitable laws are under way.

To the lumbermen of a generation ago, the much-publicized timber famine threat meant chiefly that forehanded stumpage investments promised profits. We know that, in general, such expectations have not been realized. To-day, some operators desire only to cut out and get out; while many others wish to stay in business, but are scared by government's determined fumbling with controls over industry. This means, certainly, that conditions are unfavourable for planning of sustained yield operations. Probably there is a majority of owners of sizable forests who regard such programs as admirable, but would not undertake long-time commitments in face

of to-day's uncertainties. A few can and will set them up. If governments make state and federal timber available for management jointly with suitably located private holdings, the number can be increased rather rapidly in the regions where the problem is most difficult.

In general, private forest owners and operators are not excited over this sustained yield idea. They get about and they read the Forest Survey reports, so they know that no national timber famine impends. They are agreed that the first need of forestry is effecttive protection, and they are coming to agree that the next is commonsense harvesting practices. Many believe that the progress they will make in the latter, if left to themselves, will be rapid enough. Others acknowledge that regulatory laws are necessary, to put everybody on a similar competitive plane, and to prod the indifferent. In general, I believe that forest owners and operators, and I refer to the whole mass of such citizens, prefer to have such regulation done at home, that is, by state government, rather than from Washington. It may be argued, of course, that state legislatures and state administration are responsive to local pressures; that the net result may be obstruction of needed reforms. But against this is an equally valid argument that until there is local demand for such reforms, they will be obstructed, regardless of their origin. The Congress can apply certain stimuli to local public sentiment. To succeed, the plan of application must recognize the facts which have been outlined, and their implications.—*Journal of Forestry*, Vol. 39, No. 2, dated February, 1941.

FORESTRY IN THE PAPER INDUSTRY

By Herman Work

As we all know, the wisdom of the race has often been caught best in short expressions. Such a proverb is the old favourite asserting that "*Necessity is the mother of invention*." Attributed to an English playwright of the Restoration, the idea reached him no doubt through repetition among unlettered folks down through the centuries.

Such bits of wisdom live because they have a good solid core of truth that has been recognized all along, and because of a wording

that makes the proverb shine among the dull sayings that have no touch of eternal rightness.

In our own history necessity has been a potent force. In a cynical world we may well cultivate the pride that our forbears had in the virtue of being equal to the occasion. In the arts and sciences, hard necessity has brought those advances that play such conspicuous parts in the life of our young and hardy race. Let others, if they must, submit to necessity, but we will continue, I believe, to turn the tables and make it yield new advantages and returns for our civilization, as our people have done since the days of Jamestown and Plymouth.

Is it not true that plain necessity has been a good friend to us, and to our profession as well? It is a commonplace that forestry has never been introduced except under the spur of need. So long as the original forest hung dark and menacing over our frontier settlements, there was no apparent need for care with the trees. Even now, some of the harvest problems in American forestry centre about timberlands that are not yet sufficiently needed to give them value greater than the cost of converting and moving their product to market.

The needs of industries create the conditions under which forestry may be practised, for it is markets, and markets only, that create value. Every great development in agriculture, industry, and trade has sprung from some real need that has been strong enough to provide driving power for the workers and for the savers. Certain requisites such as for police and military protection, are met only as they are needed. The specialized arts and trades of commerce have flourished best where and when they have been needed most and where free competition has given them full play.

In the manufacture of paper we have a good example of necessity creating new ideas, new materials and new methods. Balzac shows in his *Lost Illusions,* written about 1825, how the French Revolution made a new mass of readers, so great that the paper makers had difficulty in obtaining sufficient rags for their mills. The search for substitutes covered the world and kept lamps burning in many a crude attic laboratory. Wood seems to have been used first in 1840, when groundwood pulp was made in Germany. England twelve

years later contributed the soda process for cooking wood. A Philadelphian patented a sulphite process in 1867, and commercial pulp was made by that method in 1882 at Providence. The sulphate process came out in 1883, and reached our continent prior to 1907.

Markets were already waiting and anxious for better and cheaper paper. Old accounts tell of newspapers printed on a wretched straw sheet during Civil War times. There has been constant improvement in paper making ever since accentuated during the difficult sales period following 1929. All of us have noticed the great progress in reproduction of pictures, even within two or three years.

The creation of a market for wood of small sizes and for sticks too poor in quality for sawlogs brought life to many a forest area within reach of the Pennsylvania, New York, and New England mills. Following up the streams into the wilderness of mountains and lakes, often close in the wake of sawmill jobs, it was natural that all merchantable trees within reach should be cut. When blowdowns followed cutting, conditions were right for large fires. There was still plenty of uncut wood up the river or in nearby Canada, and for years the need for conservation was not apparent to most people in the industry.

As the value of young trees gradually became apparent, however, and with the passing from the region of large sawmill jobs with their heavy accumulations of slash, people began to take a different attitude towards fires in the woods, no longer considering them inevitable. Slow as people may be to recognize changing conditions, and to organize to meet them, they may be depended on to notice anything that can be converted quickly to their use or profit. They will not long postpone effective steps to protect property that can be turned to profitable use at any time, on short notice.

There had been laws against fire from the early days, when settlers were interested in saving their fences and buildings, but 1903, 1908 and 1913 were years of frightful fire losses in the northern woods and it was evident that something had to be done. Lookout towers had been introduced before 1903, and within ten years from 1913 forest fires in New York were brought under control. Vermont, New Hampshire and Maine were not far behind in confining their

fires within reasonable limits. Starting a forestry program in 1914, Virginia had reached a good degree of control by 1927. Other states have similar histories.

Cutting jobs in the pulpwood industry are characteristically small. Most of the debris is of small sizes that are readily broken down by the weather. As a result of all these conditions, the fire hazard in New England and New York is now relatively small. Compared with the South it is almost negligible from the land management viewpoint.

The paper industry has had three or four great expansion periods within the past 40 years. One followed the removal of the tariff on paper in 1913 when a number of newsprint mills were built in Canada. This expansion was revived in the early twenties, when many large new plants were built in Canada, and which undersold the older newsprint mills there and in New England, New York, and in the Lake States.

Another great expansion developed in the piney South, to meet the needs for coarse paper, and for board material required to replace the wooden box. It may be of interest to note that earlier mills had been established toward the South to use spruce wood growing on the Appalachian highlands, but the movement we have been seeing in recent years is based on the use of tree species not widely accepted heretofore for pulp making, and on the replacement of imported products by those of our own manufacture. The present trend is toward the use of pine for newsprint, as well as for kraft and white papers.

As the newly created values for pinewood gain wide recognition in the South, better forest protection is certain to follow. The great contribution that governmental forestry can make to the South to-day is in leading and organizing public effort to protect the assets of the people from the careless use of fire.

Less abrupt expansions in pulp and paper mills have occurred in the Lake States and on the West Coast. In the West the integration of pulp mills with the lumber industry to secure more complete utilization is being worked out to the benefit of timber owners, producers, and consumers of the finished product. Here the necessity of finding a market for available material is a driving force that opens up new possibilities of service from the forest.

The paper industry has been alive and alert to the necessity of organizing its wood supply. Years ago the American Paper and Pulp Association established a pulpwood section, with a forester as manager. *In 1934 the American Pulpwood Association* was organized by producers and users of pulpwood the country over, to seek better methods of meeting future as well as current needs. Many of you are familiar with the constructive self-regulatory program so well established in the South, where the Southern Pulpwood Conservation Association was organized to emphasize problems particularly affecting the South. Foundations have been laid for long range improvements in forest practice by small owners, as well as by large holders of land. All of these co-ordinated efforts show clearly that the industry has had a strong sense of responsibility for the future of the forest lands from which it draws supplies.

As people begin to realize that their young trees really bring employment and money, within a few years of their own lifetime, there is an increased tendency toward conserving the little trees, and some of the fair-sized ones too, for later cutting. Seasoned pulpwood makers know that it hardly pays to cut trees less than ten inches on the stump. Such a program of enlightened self-denial comes gradually, and not in a regimented march across the pages of history. Many a backwoods farmer has figured this all out for himself, and is regularly making a part of his living from the proceeds of his woodlands, right now. Such folks play an exceedingly important part in the progress of forestry for they have works to show, as well as faith. As pioneers demonstrate that continuous income is practicable and as markets become available to broader areas, it is reasonable to assume that less and less liquidation arrangements will be made. Where wind, fire, or bud worm hazard is great there may be no alternative to clear cutting.

It should be remembered that the backwoods pioneer must not be disappointed either as to fire prevention, or as to a market for his wood, or forestry will prove merely another case of a prophecy unfulfilled. . . . . .

The service of foresters in meeting the needs of the industry has been along three principal lines. First, they were employed to map and cruise company timber. That was their chief work for perhaps the first two decades of our century. Systematic fire-protection work

was gradually added to the forester's duties by the middle of the second decade, and about ten years ago silvicultural management began to get wider attention. A number of companies in different parts of the country had made studies and introduced varying degrees of management on their own lands, early in the century. The tendency now is not only to practise forestry on company lands but also to spread constructive ideas among other owners, and to call on them and on woods workers to take part in building for a better and more productive future.

For years the actual contracting and buying was in the hands of executives, not foresters. Now-a-days foresters tend to succeed gradually to executive posts. This is largely a personnel matter, one may suppose, but our profession is aided by having people of forestry training in such positions, for it suggests a coming of age.

Pulpwood buyers must first insure to-day's supply for the mills that give value and economic meaning to the forest. A man who does not put the current supply first is an expensive man to the industry, and to the profession, for if to-day's need is neglected, there may be no need to-morrow. After he has organized to meet the current demands he can turn to the problems of the future, and assure continuing supplies by developing sentiment against waste by fire, or neglect to build up the growing stock. One way of building such sentiment is by showing owners practical means of realizing the fullest amount from their woodlands, as by saving some trees for products of greater value. Another way to increase forest income is by early salvage of unpromising trees. It seems reasonable to predict that losses from insects and disease will be materially lowered in sections within reach of plants using large amounts of small-sized wood.

As far as I am aware, there is no disposition in the paper industry to claim much credit for what has been done. Numerous mills long ago bought extensive timberlands and put them under protection for future use. Silviculture has emerged gradually as experience has pointed the way. We all know well that the road to full stocking of our whole forest area is long, and hardly started. The industry happens to be able by its nature to do some things of considerable value for the forestry program. For one thing, it is closely tied to consumers' markets and inasmuch as paper is needed

every day, for peace and for war, for carrying the verse of a poet, as well as the bread and meat of the hungry, the market for pulpwood is relatively stable.

Prices for stumpage are usually less than for logs, certainly less than for veneer logs, but the market is far less exacting, so that the owner receives payment for practically the entire tree. Recent years have seen coming into use many species that heretofore were worthless. This trend holds great promise for improvement of the forest by removing trees of small future value. Soda process mills are more versatile in their use of various species than mills making newsprint or kraft only.

Another significant feature of the pulpwood industry from the forester's viewpoint is its employment of many people in the wooded sections, giving real, useful and remunerative work to utilize their time between crops. The principal cost of pulpwood is usually for the local labour and local transportation, rather than value added by elaborate and expensive machinery. That condition often makes it possible for the man without capital to work for himself and to profit from his own good management and application on his own property. The outstanding feature of the business, however, from the forestry view-point, is the short rotation, with frequent cuts, quick turnover, and little waste.

Just as there has been need for better ideas and better methods, there is also need for better trained foresters. In the petroleum industry it is said that only Americans have been really successful in locating oil and developing production. A leading geologist in that trade has said that "only in this country have scientists been able to get their hands dirty at menial tasks in the oil fields. Many of our geologists have taken jobs as "rough necks" and "roustabouts," advancing to drillers, foremen, scouts and lease men. Gradually geology, which previously had been a narrow path to a specialist's job in oil finding, widened into a broad avenue of approach to the whole enterprise of producing oil. Now many of the responsible executive positions in the industry as well as the humblest jobs are held by qualified geologists, and the scientific viewpoint pervades the entire industry.

Somewhere in their development, people who are going to be good foresters will have to learn some fundamentals that make for

maturity. Pulpwood foresters of the future need an intimate acquaintance with the woodsman's job and with the woodsman himself. Like the infantry platoon leader, the forester must know his weapons and his men intimately. Once mastered, this knowledge is always available, with small adjustments to suit changed conditions. The officer who has never learned the details of his weapons and the mental workings of the men in his command will always be severely handicapped. Unfortunately, his men and his cause too will suffer. Similarly, foresters of the future may well show less of the academic and office atmosphere, and may well learn to work over all the details with critical care, and try them out in practice before suggesting them to the public. We have been going through a formative and experimental stage. We should now be approaching the maturity and responsibility required by the problems we are about to face.

The obstacles or hindrances to forestry practice are all familiar. Before he can go far, the owner must be able to see, foretell or create a market. It requires a lot of courage to risk his own time and money if no market is in sight. Given a market, the technicians can tell him how to handle his property for that market. On the other hand, society as a whole needs to encourage the creation and growth of markets, as well as to assure owners and users of wood against such destructive agencies as fire, insects and disease. Over-taxation and ineffective or conflicting regulation may be equally destructive.

With the potential force of our country turning more and more strongly toward the elemental matter of defense and self-preservation, may it not be reasonably expected that forestry will become simplified to release the greatest possible contribution to the armed defense? The work that has been done in the past will be tested, showing whether forestry ideas have taken hold widely and effectively. Prevention of fire losses may be expected to hold priority as it always should. New progress in that direction should be possible under the stimulus of a roused consciousness of danger, and a new sense of patriotism.

Now that our society and our way of life are under fire, as never before, from many quarters, foresters are under the same necessity as others, to concentrate their efforts on finding practical

solutions. Necessity may not much longer permit us to waste our force in fruitless divisions or on projects of doubtful value that distract our attention from the main effort. In a rapidly changing world, simplicity and economy of operation may be requisites for survival. Under increasing pressure we should concentrate on the essentials and on the productive areas, thus insuring the maximum net contribution of forestry for to-day and for to-morrow as well. Such concentration on the main effort might well bring to forestry a new feeling of assured power and usefulness.—*Journal of Forestry*. Vol. 39, No. 2, dated February, 1941.

SOIL EROSION AND ITS CONTROL

By A. K. Bose

Until quite recently erosion was regarded as a matter of merely local concern, ruining a few fields and farmsteads here and there, and compelling the occupiers to abandon their homes and move on to a new land, but it is now recognised as a contagious disease spreading destruction far and wide irrespective of private, state or national boundary. Erosion can be easily checked in its early stage; but when it has advanced to the stage when it threatens the entire social structure its control becomes extremely difficult.

The most potent and common causes of contemporary erosion in India are deforestations and overgrazing. Much of the weight of the increasing population in India is falling upon the tension belt where grassland can persist only under reasonable treatment and if once destroyed cannot reinstate itself as easily as it can under a slightly heavier or better distributed rainfall. Hence over a very large tract of the country natural grasslands have already disappeared.

The three most active eroding forces are water, wind and ice. Wind is directly responsible for sand and dust storms and is indirectly responsible for wave erosion along the shorelines of oceans.

Water erosion is generally considered to manifest itself in two forms: (1) Sheet washing and (2) gullying. Usually these two forms represent different stages in the same process and gullies as a rule do not appear until sheet erosion has been under way for a considerable time. Gullies, however, sometimes occur without being preceded

by sheet erosion; and conversely, sheet erosion has been known to continue indefinitely without the formation of gullies.

Sheet Erosion.—At the time when the seedbed for Kharif crop is ploughed and the soil pulverized, the rains set in and when intense rain falls on the ground, it first packs the soil, but in so doing the finer particles of soil float and as water flows down the slopes, it carries away with it soil and humus. Since water is falling simultaneously on all parts of the fields, the mixture of soil and excess water progressively increases in thickness as it moves in a thin sheet from top to bottom. The result is a rather uniform skimming off of the cream of the top soil with every hard rain. This process is insidious because it may or may not leave any visible trace of damage and may go on for years under the eyes of a farmer who does not realise his loss and cannot understand why the productivity of his land is decreasing.

Gully Erosion.—Once water begins flowing in a definite channel the eroding power of a given volume on a given slope is greatly increased. There are two general types of gullying: (1) ditch erosion occurs where the head and sides of the gully are usually sloping and erosion occurs at the head, sides and bottom of the gully in varying degrees by the action of water; (2) waterfall erosion is caused by water falling over the edge of a gully or ditch or bank and is often responsible for many of the deepest gullies. The falling water undermines the edge of the bank, which caves in and the waterfall moves upstream.

Gully erosion is much more noticeable than sheet erosion, and for this reason is generally considered more serious than sheet erosion. This, however, is a false impression because the first and most serious damage results from sheet erosion.

Causes of Erosion.—The major causes of soil erosion are: (1) the slope of the land—the more the slope, the more run-off and hence more erosion; (2) the nature of the soil—the harder and more compact the soil is the less erosion, and the looser the soil is the more erosion; (3) the rainfall—the amount, intensity and duration of rainfall each affects the run-off.

Besides these the common practices which assist erosion are the following: (*a*) square farming, (*b*) cultivating in the direction of the

slope, (*c*) failure to attend to small "washes" before they develop into gullies, (*d*) bare fallowing, (*e*) indiscriminate clearing of timber and undergrowth on steep slopes and on the banks of watercourses, (*f*) failure to practise suitable crop rotations, (*g*) insufficient pasture areas, (*h*) the bringing of fields with a slope greater than 15 per cent. in cultivation.

Wind Erosion.—Although wind action in the remote past is responsible for the formation of large areas of present-day farmland, it might seem that modern climatic conditions are not such as to permit wind erosion to attain major significance.

Effects of Erosion.—The effects of erosion are as follows: (1) Loss of the most fertile soil. (2) Changes in the soil structure, caused by the (*i*) loss of organic matter, and (*ii*) the washing away of finer soil particles. (3) Loss of land. (4) Decrease in the capillary capacity of the soil by changing the soil structure. (5) Loss of moisture.

CONTROL OF SOIL EROSION

I.—By the Use of Crops, Trees, Creepers, etc.

(1) *By using cover crops.*—The role of plant life in soil and water conservation is one of transcending importance. A thick stand of crop or trees growing over areas of appreciable size affords one of the best possible protections against erosion. A dense foliage canopy, a ground mat of leaves and extensive root development make a combination which renders the soil practically invulnerable.

(2) *Sound Rotation.*—The rotations to be practised are to be such as would (1) minimise periods to fallow, (2) produce crops producing a dense stand, (3) provide nitrogen for the soil. The following rotation typical to dryland is followed in some parts of India:

1st year—mixture of dry paddy and red gram.

2nd year—Chillies with rows of cotton at intervals.

3rd year—Groundnut followed by coriander or Bengal gram or fodder sorghum.

(3) *Growing of grasses and creepers.*—Soil binding may be effected with revegetation by suitable ecological material. The trees that are used for the purpose, in the several countries of the world, are Acacias, Cassia siamea, Pines, spineless cactus and willows. The various soil-binding creepers are; *Pueraria thumbergiana* or the kudzu vine, *Bignonia radicaus* or the Trumpet creeper, *Ipomea*

biloba or the sand-binding weed. And some of the most effective grasses are: *Cynodon dactylon* or the dub grass, *Pennisetum clandestinum* or the kikuya-grass, *Andropogon pertusus* or the Janai grass.

Effects of vegetation.—(1) A covering of vegetation checks the flow of run-off water. (2) The roots of plants hold the soil against washing. (3) It reduces the force with which the rain hits the soil and thereby retards erosion. (4) A vegetative covering of the soil increases the amount and rapidity of water entering the soil.

II.—By Contour Cultivation and Strip Cropping

Contour cultivation is the growing of crops along the contour lines, i.e., in a line which has the same elevation. These lines are at right angle to the slope.

Strip cropping is the practice of planting strips of densely growing crops along the contoured lines of a slope between strips of the main crop of the field. This system tends to decrease both soil and water loss. The effectiveness of the strip is proportional to the width of the strip. In addition to minimising erosion, strip cropping is also effective in cutting down soil losses through wind action under certain conditions.

III.—By Terracing

A terrace is any obstruction in the form of a ridge of earth thrown up across a slope so as to retard the flow of water and hold it until it is absorbed.

For centuries, agriculturists of other countries have used terraces effectively to combat soil erosion and facilitate tillage practices on sloping lands. Certain types of terraces are almost as old as agriculture itself. More than 4,000 years ago the Incas terraced their steep hillsides, and over 2,000 years ago the present practice of terracing rice fields in the Phillipine Islands was begun by the natives. The terraces of the vineyards of Europe, the terraced fields of the orient, and the more recent terracing of wheat fields in Australia are all evidences that terracing is being widely adopted. Although the old type hillside ditches or terraces very frequently failed, they were sufficiently successful to induce farmers to continue their use year after year.

Terracing, supported by necessary cropping practices, is primarily applicable on sloping lands that must be used for crops and on which less expensive conservation measures will not provide adequate erosion control. Neither can terracing be economically justified on lands that can be adequately protected by proper tillage, and agronomic measures such as contour tillage, crop rotations and strip cropping. These measures alone may provide sufficient protection where relatively low rainfall intensities and high soil infiltration rates are encountered and where an erosion resistant cover crop can be had during the rainy seasons. But where erodible soils, long slopes, and high rainfall intensities are encountered and where a large percentage of the erosion permitting crops must be used in the rotation profitably, the applicable agronomic control measures may give only partial control and must then be reinforced with terracing. Terraces should be always supplemented with the best possible cropping practices because terraces themselves do not improve soil fertility but serve primarily as a basis for soil improvement and other conservation practices. The use of proper rotations and contour strip-cropping and cultivation in conjunction with terracing provides one of the most effective erosion control combinations now known for cultivated fields.

Advantages and Disadvantages.—When properly applied, constructed and maintained, terraces are valuable conservers of soil on practically all soil types. They reduce the annual run-off losses on certain soil types and materially reduce the rate of run-off from small cultivated fields. Combined with other beneficial and allied practices such as rotations within the field, strip cropping, and contour cultivation, terraces save fertile top soil and retain costly seed and applications of lime and fertilizer. The fact that terraces help to conserve soil justifies the expectation that terraced fields will produce better crop yields over a period of years than unterraced fields, which may deteriorate rapidly in crop producing value because of erosion losses.

Terraces are somewhat costly to build and require some maintenance. Their use may require abrupt changes in traditional farming practices and entail slightly higher tillage costs. Terracing on thin soils may expose subsoil in the terrace channels. Drainage may

also result from the diversion and concentration of run-off at uncontrolled points unless precaution is exercised.

Types of Terraces.—Terraces are classified according to function: (1) The drainage type and (2) the absorptive type. When the construction characteristics alone are considered a corresponding classification would be (1) the channel type and (2) the ridge type. Classification according to construction should include a third type, the bench terrace, which is used for steeper slopes. In some sections of the country both drainage and absorption are important objectives in terracing, but there are long sections where drainage is of primary importance and other areas where absorption is the principal requirement. In regions of moderate rainfall and favourable soil condition intermediate terrace requirements will be encountered and a dual purpose terrace incorporating the desired feature of both the drainage and absorptive types can be used.

Drainage type.—This type acts primarily as a drainage channel to conduct excess rainfall from the fields at non-erosive velocity. Since low velocity surface drainage is required, the channel and not the ridge is of primary importance. A wide relatively shallow channel of low gradient that has gentle side slopes and ample water capacity will give good results. This is applicable to soil types that are relatively impervious.

Absorptive type.—In order to increase absorption the terrace is constructed so as to flood collected run-off over as wide an area as possible. If this is to be done effectively the surface slopes on which the terraces are built should be fairly flat, the ridge should be sufficiently high to retain water over a relatively large surface, and the earth required for the ridge so excavated as to avoid concentration of run-off on a small area. In this type of terrace the ridge is of greater importance than the excavated channel, which is more or less incidental to the construction of the ridge. The absorptive type terraces are adaptable to areas of low precipitation and to soil types that will absorb the accumulated run-off fast enough to prevent damage to growing crops.

Bench type.—This consists of building relatively steep land into series of level or nearly level strips running across the slope. The strips are separated by almost vertical banks, which are retained by

rock or a heavy growth of vegetation. It is one of the oldest mechanical methods of erosion control, having been used for many centuries in thickly populated countries where economic condition necessitated the cultivation of steep slopes. The use of the bench terrace on steep slopes not only retards erosion-losses but also facilitates cropping operations on these slopes.

Mr. Mangum of Wake Forest, North Carolina (U.S.A.) introduced a wide base terrace in which tillage operations could be conducted over the entire terrace. A modification of this terrace is extensively used now-a-days and is known as Mangum terrace. The best possible protection against erosion is the use of Mangum terraces so combined with strip cropping as to keep a dense growing crop on the terrace throughout the wet season and to do all cultivation along contour lines.

For laying out Mangum terraces one must first know the following: (1) possible outlet, (2) slope of the land, and (3) character of the soil.

DISTANCE BETWEEN TERRACES

Slope of the land per 100 ft.	*Vert. Dist. Or drop between terraces*	*Length per acre*
Less then 1 foot	1 foot	..
One foot	1 foot	220 ft.
2 ft.	2½ ft.	320 ft.
3 ft.	2¾ ft.	..
4 ft.	3 ft.	515 ft.
6 ft.	3½ ft.	655 ft.
8 ft.	4 ft.	745 ft.
10 ft.	4½ ft.	795 ft.
12 ft.	5 ft.	830 ft.
14 ft.	5½ ft.	860 ft.

A uniformly graded terrace is one which has a uniformal grade (or fall) per 100 ft. throughout the length of the terrace. A variable graded terrace has a grade which increases from the upper to the outlet end of the terrace.

Length of Terrace.—Terraces should not be more than 1,200 ft. long for good results. The shorter ones are much better. The uniform grade of 6 inches in 100 ft. is recommended for general use. It is believed that a greater volume of water flowing in the terrace causes more erosion and carries away more soil than has moved down the slope into the terrace channels. The terrace should be made 18 inches high. This allows 3 inches for rounding off the top and 3 additional inches for settlement, still leaving the firm settled terrace 12 inches high.

Construction of the Terrace.—(1) First the terrace lines are constructed either with regular surveying instruments or with a home-made wooden level. Either method is accurate.

Establishing terrace lines with home-made level:—One block at the end of the level is set one inch lower than that of the other by a bolt arrangement which fastens the block to the frame. The longer leg is placed on the point which marks the outlet end of the terrace. Then the other leg is moved up and down the slope till the spirit level shows that the instrument is level. This establishes a point one inch higher than the starting point at the outlet end. A wooden stake is fixed at this point with its top levelled with the ground. Then the longer leg is put on this stake and the process is repeated. Repeating this process across the field locates a terrace line with a slope of 6 inches in 100 ft. Before starting the actual construction of the terrace it is necessary to even out the sharp angles in the line of stakes by making a furrow along this line with a plough drawn by bullocks. The following are essential for a good terrace: (1) It must be high enough to hold the run-off water from the heaviest rain with reasonable safety. (2) It must be broad enough so that implements can be used on it without undue strain on the implements or damage to the terrace. (3) The channel on the upper side of the terrace should be sufficiently wide to take care of the run-off water.

Methods of making Terraces.—There are 3 methods:—

1. *Pharwa* and basket. 2. Plowing and scraping.

3. Tractor and one-way disc plough.

Ploughing and scraping method.—A strip six feet wide is ploughed above the established line of the terrace. Then the scraper from the upper layer of this strip is run crossing the plough land diagonally so as to get a full load and empty this earth on the solid

soil just below the ploughed strip. The scraping is started a little above the ploughed strip as otherwise too steep a drop into the terrace will result. Afterwards the terrace is evened up and extra soil is put on the low places. This is allowed to settle and a good cover crop is sown on it. This protects the terrace while setting.

Outlets for Terraces.—This is the most important problem in terracing. The water must be carried away from the ends of the terraces. Under Indian conditions the outlet channels should always be sodded, i.e., it should always have a closely growing grass like doob, bandaria, or janai. The channels should have one per cent. grade to prevent erosion.

Control of Gully.—There are three ways of checking gully erosion: (1) stopping head growth, (2) prevention of floor scouring and side ersion, and (3) reclamation of gully.

Stopping head erosion.—It is essential to construct a diversion ditch that will collect the water above the head of a gully and carry it away slowly to a proper outlet thus preventing it from falling over the head of the gully. Where it is impossible to prevent flow of water over the headwall of the gully it is necessary to provide some type of structure through which water can face on the floor of the gully. Such a structure may be an open flume, or a closed culvert of wooden plank, galvanised iron sheet or concrete. Such a dam must be provided with a weir notch, apron and side walls to control the energy of the falling water.

Prevention of Floor Scouring and Side Erosion.—Once the head growth is stopped, next the velocity of the water flowing through the gully floor must be checked. This may be done by putting check dams across the gully floor at frequent intervals for its entire length. Except at the outlet it is usually sufficient to construct check dams of loose rocks, woven wire or logs of wood and bushes. As soon as the first dams are filled to the top with eroded material, new ones should be built. Check dams should always be made lower at the centre than at the edges so that water will not cut round them.

Reclamation of a Gully.—In any gully of appreciable size there should be one or more soil scouring dams of masonry or earth, so constructed as to retain the silt burden but let water pass. The spillway of the dam should be constructed of pukka masonry, brick, cement or concrete. It should have a capacity larger than the

channel required for carrying the stream in flood time. The crest of the spillway should be built in the form of an arc. The dam should be so constructed that water never flows over any other position of the dam. It can be made of earth but it should be at least 1 foot higher than the spillway. The portion of the dam made of earth should have grass growing on it.

References.—1. Soil Erosion Control—University of Minnesota Special Bulletin 171—August, 1935.

2. Terracing for Soil Conservation, U.S.D.A. Farmer's Bull., 1789.

3. Soil Erosion Control by Burges.

4. Soil Erosion Control by Ayres.

5. Queensland Agricultural Journal. August, 1939.—*The Allahabad Farmer,* Vol. XV, No. 3, dated May, 1941.

INDIAN FORESTER

SEPTEMBER, 1941

VICTORY

CONTROLLED BURNING AND CHANGE IN VEGETATION

BY N. P. MOHAN, I.F.S.,

Silviculturist, Punjab

Summary.—Details of ground flora in 8 transects situated in burnt and unburnt *Pinus longifolia* sample plots are recorded both for June and September. Species peculiar to the burnt and unburnt transects are listed. Area under blanks is greater in the burnt transects which have comparatively less vegetation. *Premna herbacea*, amongst others, is peculiar to the burnt transects. It is the first attempt of work of this kind.

Two sample plots were laid out in Rawalpindi East Division in 1913 in *Pinus longifolia* forest to determine (in addition to volume increment and development of young pole crop) the effect of controlled burning on the fertility of the soil as exhibited in the volume increment of trees. Both the plots are contiguous and are situated at 2,850 feet above sea level with a rainfall of 42 inches. Rock is disintegrated sandstone and soil is sandy with an admixture of gravel and clay. The average slope is about 30° and aspect is western to north-western. At the time of formation the crop was a young pole

forest of medium quality and of 40—43 years in age. One plot (S. P. No. 5) has been burnt departmentally almost regularly every alternate year from 1913 while the other has been kept unburnt. About 1937, it was realised that in investigating the effects of early burning on the soil and the vegetative complex in general and *chir* regeneration and growth in particular, it was necessary to consider the forest as a whole rather than restrict the investigation to the effect on single-tree species. In other words, the investigation should have been an ecological one as these two sample plots provided the best material for an ecological study on the results of burning than any other available area. It was seen that the treatments had had no noticeable effect on the growth of the standing tree crop but no record was available of any changes in undergrowth, etc., that might have taken place. The only difficulty apprehended in the proposed ecological study was to know whether there was any initial difference in soil and ground flora between the two plots or whether they were reasonably similar. This was sought to be overcome by judging on the ground from the surrounds. The plots on the ground appeared reasonably similar and three transects six feet wide (in all 70 squares six by six feet) in the burnt Sample Plot No. 5 and five transects six feet wide (in all 70 squares six by six feet) in the unburnt Sample Plot No. 6 were laid out for recording the ground vegetation in 1937. Assessment lists were prepared in September, 1937, and again in June, 1938.

It must have been observed that the area assessed was of the same extent, viz., 70 squares, each six by six feet (or 2,520 square feet) in a number of transects. The vegetation of each square was assessed separately and the assessment was carried out by the square foot density method, i.e., by recording the area occupied by each species in square feet. The unit of assessment for blanks and *Themeda anathera* (the commonest species) was kept as one square foot and for sparse grasses, weeds, shrubs, etc., a quarter square foot. In actual recording a quarter square foot represented area varying from $\frac{1}{8}$ and $\frac{3}{8}$ square foot; and half square foot variation from $\frac{3}{8}$ and $\frac{5}{8}$. If any species occupied less than $\frac{1}{8}$ square foot, its area figure was ignored but the counts were registered. The assessments for the 70 squares were then grouped and the Table (pp. 453-454) summarises the results.

Family	Name	TRANSECTS IN UNBURNT S. PLOT — *Sept.* 1937 *assessment* No.	% of area occupied.	*June* 1938 *assessment* No.	% of area occupied.	TRANSECTS IN BURNT S. PLOT. — *Sept.* 1937 *assessment* No.	% of area occupied.	*June* 1938 *assessment* No.	% of area occupied.
Bixineæ ..	*Flacourtia ramontchi* ..	7	0.02	6	0.02	3	0.02	6	0.03
Polygaleæ ..	*Polygala leptalea, DC.* ..	..	..	8	..	..	..	5	..
	,, *chinensis* ..	70	0.03	..	..	77	0.01	..	..
Geraniaceæ ..	*Oxalis coniculata* ..	254	0.29	214	0.08	41	0.01	42	..
Meliaceæ ..	*Cedrela toona* ..	..	..	1	..	..	..	..	..
Sapindaceæ ..	*Dodonaea viscosa* ..	2	0.04	1	0.02	1	..	..	..
Anacardiaceæ ..	*Lannea grandis* ..	..	..	..	..	1	0.02	1	0.01
Leguminosæ ..	*Crotalaria medicaginea* (var. *herniarioides*) ..	105	0.26	76	0.06	47	0.15	42	0.04
	Cassia mimosoides (var. *wallichiana*) ..	50	0.03	..	..	43	0.02	..	..
	Desmodium gangeticum	7	0.01	8	0.02	13	0.02	9	..
	Flemingia congesta (var. *prostrata*) ..	..	..	..	..	26	0.03	21	0.01
	Vigna vexillata ..	..	..	..	..	1	0.02	1	0.01
	Phaseolus aconitifolius ..	13	0.04	..	..	4	0.01	..	..
	Rhynchosia minima ..	15	..	9	..	5	..	4	..
	Acacia eburnea ..	4	0.04	4	0.02	3	0.14	2	0.06
Lythraceæ ..	*Punica granatum* ..	10	0.03	6	0.01	6	..	..	..
	Woodfordia floribunda ..	1	0.01	..	..	..	..	..	..
Rubiaceæ ..	*Wendlandia exserta* ..	1	0.02	1	0.01	..	..	..	..
	Spermacoce stricta ..	111	0.09	3	..	465	0.20	1	..
Compositæ ..	*Inula cappa* ..	79	0.17	45	0.02	4	..	1	..
	Sonchus arvensis ..	148	0.28	113	0.03	105	0.13	64	..
	Senecio nudicaulis ..	624	0.97	460	0.18	394	0.50	290	0.01
	Vernonia cinerea ..	..	..	..	..	..	..	19	0.01
	Conyza japonica ..	..	..	1	..	30	0.01	..	..
Apocynaceæ ..	*Carissa spinarum* ..	63	2.45	66	2.28	40	1.43	39	1.20
Acanthaceæ ..	*Barleria cristata* ..	161	0.32	147	0.10	158	0.18	163	0.06
Verbenaceæ ..	*Premna herbacea*, Roxb.	..	..	..	..	..	..	20	0.01
Labiatæ ..	*Miscromeria biflora* ..	4	0.01	4	..	..	..	..	..
Euphorbiaceæ ..	*Euphorbia emodi* ..	180	0.07	..	..	250	0.08	..	..
	Phyllanthus niruri ..	152	0.12	..	..	1,230	0.51	..	..
	Glochidion velutinum ..	1	0.01	1	..	11	0.19	8	0.12
Coniferæ ..	*Pinus longifolia* ..	3	0.14	3	0.14	3	0.18	3	0.18
Polypodiaceæ ..	*Cheilanthes farinosa* ..	9	0.01	8	0.01	..	..	1	..
	? ..	..	..	..	..	33	0.08	..	..
	? ..	22	0.03	..	..	5	..	1	..
Gramineæ ..	*Themeda anathera* ..	..	47.84	..	45.77	..	25.09	..	22.26
	Dichanthium annulatum	..	0.04	..	..	..	..	..	..
	Chrysopogon montanus ..	..	0.22	..	0.18	..	0.10	..	0.04
	Ischaemum augustifolium	..	0.14	..	0.16	..	0.02	..	0.07
	Heteropogon contortus ..	..	0.02	..	0.02	..	..	..	..
	Brachiaria ramosa ..	..	0.12	..	..	..	0.09	..	0.02
	Total ..	53.87	..	49.13	..	29.24	..	..	24.13
	Blank ..	..	46.13	..	50.87	..	70.76	..	75.87

The data may be condensed as under by natural families:

Family		Transects in Unburnt S. Plot.				Transects in Burnt S. Plot.			
		Sept. 1937 *assessment*		*June* 1938 *assessment*		*Sept.* 1937 *assessment*		*June* 1938 *assessment*	
		No.	% of area occupied	No.	% of area occupied	No.	% of area occupied	No.	% of area occupied
Bixineæ	..	7	0.02	6	0.02	3	0.02	6	0.03
Polygaleæ	..	70	0.03	8	..	77	0.01	5	..
Geraniaceæ	..	254	0.29	214	0.08	41	0.01	42	..
Meliaceæ	..	..	..	1	..	..	..	..	..
Sapindaceæ	..	2	0.04	1	0.02	1	..	..	..
Anacardiaceæ	..	..	..	..	..	1	0.02	1	0.01
Leguminosæ	..	194	0.38	97	0.10	142	0.39	79	0.12
Lythraceæ	..	11	0.04	6	0.01	6	..	..	..
Rubiaceæ	..	112	0.11	4	0.01	465	0.20	1	..
Compositæ	..	851	1.42	619	0.23	533	0.64	374	0.02
Apocynaceæ	..	63	2.45	66	2.28	40	1.43	39	1.20
Acanthaceæ	..	161	0.32	147	0.10	158	0.18	163	0.05
Verbenaceæ	..	..	..	..	..	..	..	20	0.01
Labiatæ	..	4	0.01	4	..	..	..	..	..
Euphorbiaceæ	..	333	0.20	1	..	1,491	0.78	8	0.12
Coniferæ	..	3	0.14	3	0.14	3	0.18	3	0.18
Polypodiaceæ	..	9	0.01	8	0.01	..	..	1	..
?	..	22	0.03	..	..	38	0.08	1	..
Gramineæ	..	..	48.38	..	46.13	..	25.30		22.39
Total	..	..	53.87	..	49.13	..	29.24	..	24.13
Blanks	..	..	46.13	..	50.87	..	70.76	..	75.87

Before interpreting the vegetation two possible objections may be considered:

(*a*) When the two sample plots were laid out in 1913, the vegetation was not charted and there is no statistical evidence to show that the two plots were ecologically similar. This is so but the situation and history of the plots warrant the inference that for practical purposes they were initially so.

(*b*) The plots have been open to grazing and consequently the burn may have been very light. Grazing in itself will also cause an interaction because the proportion of palatable grasses and herbs will be reduced by grazing irrespective of burning. This is true but burning will naturally accentuate the succession or retrogression and change in the relative abundance of species.

The vegetation data gives the following information:

(*i*) The area under blanks in the unburnt transects varies from 46.13 per cent. (September figures) to 50.87 per cent. (June figures) while in the burnt it is as high as 70.76 to 75.87. It is not unreasonable to infer that controlled burning has led to the creation of blanks.

(*ii*) Of the vegetation, the largest area is occupied by *Gramineæ* in all the transects, viz., 48.38 (September) to 46.13 per cent. (June) in the unburnt transects and 25.30 (September) to 22.39 per cent. (June) in the burnt area. The reduction of the area under grasses due to controlled burning is apparent. The area occupied by every grass species is less in the burnt transects.

(*iii*) The dominant grass in each transect is *Themeda anathera,* which according to Kangra analysis, is peculiarly deficient in phosphates consequent upon phosphate deficiency in the soil. *Heteropogon contortus* (with a constant area in September and June assessment) is found only in the unburnt transect and is entirely absent in the burnt; *Dichanthium annulatum* is another grass showing the same distribution but it disappears in June count in the unburnt transects. *Brachiaria ramosa* is present both in the unburnt and

burnt transects but in the June count it vanishes from the unburnt transects. It is, however, present both in the September and June counts in the burnt transects though in the latter its area of occupation is considerably reduced.

(*iv*) Of the natural families occupying more than 0.1 per cent. of the area in the unburnt transects, *Apocynaceæ* (2.45), *Compositæ* (1.42) and *Leguminosæ* (0.38) occupy the largest area in the September count. Their ascendancy (2.28, 0.23 and 0.10) is maintained in the June count though the fall in the area is considerable. *Apocynaceæ* holds the first position on account of *Carissa spinarum* which depends on suckers for propagation and not on seed. The dominant species in the *Compositæ* are *Sonchus arvensis* and *Senecio nudicaulis*. In the *Leguminosæ, Desmodium gangeticum* and *Acacia eburnea* are present both in the September and June count; *Cassia mimosoides* though present in September disappears in June and so is the case with *Phaseolus aconitifolius*, while the number of *Crotalaria medicaginea* and *Rhynchosia minima* is reduced in June. In the burnt transects, the same three families predominate (though the area occupied is considerably less as compared with the unburnt transects) in addition to *Euphorbiaceæ* which holds second position. *Apocynaceæ* leads again due to *Carissa spinarum*. There is a great influx of *Phyllanthus niruri* in the September count but it entirely disappears in June while *Glochidion velutinum* is more or less constant and more numerous. Of the *Compositæ, Vernonia cinerea* is peculiar to the burnt transects and appears only in June count and *Conyza japonica* is more numerous than in the unburnt transects but disappears in June. Other *Compositæ* species are less in number than in the unburnt transects. *Inula cappa* suffers the heaviest mortality in June while the dominant (in number) species are *Sonchus arvensis* and *Senecio*

nudicaulis though the area occupied by them in June is very much less. Of the leguminous flora, the area occupied in the burnt and unburnt transects in September is more or less the same and mortality by June nearly equal. *Flemingia congesta* and *Vigna vexillata* are peculiar to the burnt transects. *Crotalaria medicaginea, Desmodium gangeticum, Rhynchosia minima* and *Acacia eburnea* are more or less constant in number both in September and June assessments but *Cassia mimosoides,* as in the unburnt transects, disappears in June.

It is, however, more instructive to compare each species in the two kinds of transects and group them according to their characteristics. The following statement supplies this information:

A. (*i*) Species which are met with in the unburnt transects but not in the burnt transects in September.	*Woodfordia floribunda* *Wendlandia exserta* *Micromeria biflora* *Cheilanthes farinosa* *Dichanthium annulatum* *Heteropogon contortus*
(*ii*) Species which are met with in the unburnt transects but not in the burnt transects in June.	*Cedrela toona* *Dodonaea viscosa* *Punica granatum* *Wendlandia exserta* *Conyza japonica* *Micromeria biflora* *Heteropogon contortus*
B. (*i*) Species that are met with in the burnt transects but not in the unburnt transects in September.	*Lannea grandis* *Flemingia congesta* *Vigna vexillata* *Conyza japonica* ? Name not known.
(*ii*) Species that are met with in the burnt transects but not in the unburnt transects in June.	*Lannea grandis* *Flemingia congesta* *Vigna vexillata* *Verononia cinerea* *Premna herbacea* ? Name not known. *Brachiaria ramosa.*
C. (*i*) Species that appeared anew or increased in number in the burnt transects in June as compared with Sept. count.	*Flacourtia ramontchi* *Polygala leptalea* *Vernonia cinerea* *Barleria cristata* *Premna herbacea* *Cheilanthes farinosa* *Ischaemum angustifolium*

(*ii*) Species that disappeared or decreased in number in the burnt transects in June as compared with Sept.	*Polygala chinensis* *Dodonaea viscosa* *Crotalaria medicaginea* *Cassia mimosoides* *Desmodium gangeticum* *Flemingia congesta* *Phaseolus aconitifolius* *Punica granatum* *Spermacoce stricta* *Inula cappa* *Sonchus arvensis* *Senecio nudicaulis* *Conyza japonica* *Euphorbia emodi* *Phyllanthus niruri* *Glochidion velutinum* ? Name not known. *Themeda anathera* *Chrysopogon montanus* *Brachiaria ramosa*
(*iii*) Species that have remained more or less constant in number in June and Sept. counts in the burnt transects.	*Oxalis corniculata* *Lannea grandis* *Vigna vexillata* *Rhynchosia minima* *Acacia eburnea* *Carissa spinarum* *Pinus longifolia*
D. (*i*) Species that have appeared anew or have increased in number in the unburnt transects in June as compared with Sept. count.	*Polygala leptalea* *Cedrela toona* *Conyza japonica* *Carissa spinarum* *Ischaemum augustifolium*
(*ii*) Species that disappeared or decreased in number in unburnt transects in June as compared with September.	*Polygala chinensis* *Oxalis corniculata* *Dodonaea viscosa* *Crotalaria medicaginea* *Cassia mimosoides* *Phaseolus aconitifolius* *Rhynchosia minima* *Punica granatum* *Woodfordia floribunda* *Spermacoce stricta* *Inula cappa* *Sonchus arvensis* *Senecio nudicaulis* *Barleria cristata*

D. (*ii*) Species that disappeared or decreased in number in unburnt transects in June as compared with September.—(*concld.*)	*Euphorbia emodi* *Phyllanthus niruri* ? Name not known. *Themeda anathera* *Dichanthium annulatum* *Chrysopogon montanus* *Brachiaria ramosa*
(*iii*) Species that remained more or less constant in June and September in the unburnt transects.	*Flacourtia ramontchi* *Desmodium gangeticum* *Acacia eburnea* *Wendlandia exserta* *Micromeria biflora* *Glochidion velutnum* *Pinus longifolia* *Cheilanthes farinosa* *Heteropogon contortus*

D(*iii*) (i.e., constant species) and D(*i*) for the unburnt transects indicate the result of succession that has taken place in them while D(*ii*) includes species which may entirely disappear or show a seasonal increase or decrease. Sub-divisions of C give the same information for the burnt transects. A and B are more interesting as they show comparative vegetation for the burnt and unburnt transects and the species peculiar to each. All the species recorded have a wide distribution but *Premna herbacea* peculiar to the June assessment of unburnt transects calls for a few remarks. It is a plant of stiff soils in open grassy places but Parker has seen no Punjab specimens (page 400 of Parker's *Forest Flora* for the Punjab with Hazara and Delhi). It is supposed to have been permanently dwarfed by periodic jungle fires and its appearance only in the burnt transects in June is of peculiar interest.

Conclusion.—It is the first attempt to record the ground flora in a *Pinus longifolia* forest and though for recording no better sets of comparative transects were available, the mode of recording could have been better. The transects failed to secure the blessings of the statisticians but the results are published as a pioneer attempt in what may at first sight appear as a simple and easy task but is in reality a very laborious undertaking.

SUMMARY OF REVENUE AND EXPENDITURE AND SURPLUS OF THE FOREST

Heads	Imperial	Bengal	United Provinces	Punjab	Bihar	Orissa	Assam	Central Provinces and Berar
Revenue—								
Timber and Other Products—								
1938-39 ..	..	22,41,206	54,51,910	23,02,776	7,73,314	6,36,814	16,69,298	48,68,288
1939-40 ..	..	23,98,085	56,57,489	25,39,547	8,36,148	6,53,016	17,45,412	50,43,788
Expenditure—								
Conservancy, Maintenance and Regeneration—								
1938-39 ..	..	6,82,183	12,18,349	15,33,183	1,64,432	2,87,965	3,43,082	14,72,850
1939-40 ..	..	6,79,974	11,68,016	12,47,162	1,73,384	2,99,804	3,67,023	15,05,465
Establishment—								
1938-39 ..	52,626	10,10,532	18,63,343	11,21,855	4,31,224	3,55,886	8,17,631	20,15,315
1939-40 ..	40,145	10,60,078	18,82,755	12,60,519	4,26,460	3,43,671	7,93,935	20,31,116
Total of Expenditure—								
1938-39 ..	52,626	16,92,715	30,81,692	26,55,419	5,95,656	6,43,851	11,60,713	34,88,165
1939-40 ..	40,145	17,40,052	30,50,771	25,07,980	5,99,844	6,43,475	11,60,958	35,36,581
Surplus (+) or Deficit (−)								
1938-39 ..	−52,626	+5,48,491	+23,70,218	−3,52,643	+1,77,658	−7,037	+5,08,585	+13,80,123
1939-40 ..	−40,145	+6,58,033	+26,06,718	+31,567	+2,36,304	+9,541	+5,84,454	+15,07,207

DEPARTMENT IN INDIA, FOR THE FINANCIAL YEARS 1938-39 and 1939-40

Coorg	North-West Frontier Province	Ajmer-Merwara	Baluchistan	Andamans	F. R. I. and College	Madras	Bombay	Sind
3,13,605	5,98,819	54,250	1,75,026	16,05,609	1,50,124	43,86,944	40,60,206	8,64,687
3,26,566	5,22,025	43,488	1,60,558	12,79,818	1,59,936	42,91,828	38,60,605	7,76,348
69,027	1,58,730	16,268	1,01,070	10,52,315	86,947	14,20,000	6,75,024	26,153
79,162	1,59,749	16,597	1,09,147	10,05,990	76,735	13,93,915	6,81,913	51,930
1,15,191	2,22,871	31,602	35,011	1,66,613	6,27,666	25,78,784	20,12,112	3,24,575
92,102	1,92,582	25,914	37,849	1,68,320	6,17,147	24,62,586	19,47,953	3,13,850
1,84,298	3,81,601	48,870	1,36,081	12,18,928	7,14,613	39,98,784	26,87,136	3,50,428
1,71,264	3,52,331	42,511	1,46,996	11,74,310	6,93,882	38,56,501	26,29,866	3,65,780
+1,29,307	+2,17,218	+6,380	+38,945	+3,86,681	−5,64,489	+3,88,160	+13,73,070	+5,14,259
+1,55,302	+1,69,694	+977	+13,562	+1,05,508	−5,33,946	+4,35,327	+12,30,739	+4,10,568

EROSION IN THE *YOMAS* OF THE NORTH PEGU FOREST DIVISION

BY D. E. B. MANNING, I.F.S.

It is generally accepted that soil erosion on forested land is less than on agricultural areas. There can be no argument on this accepted fact in temperate climates where the forest soil is protected by undergrowth or a heavy layer of leaf mould, forest litter and a soil rendered porous by humus. In such conditions, rainfall is absorbed and retarded in its passage over the soil by mechanical means, the water so held is allowed to pass gradually into the soil and subsoil and there is but little that passes over the surface to cause sheet erosion.

In Burma, however, forest conditions are probably not effective in preventing soil erosion in the drier types of forest that are subject to annual fires. The reason for this is simple. After leaf fall, in March, the annual ground fires are very fierce and they destroy all the normal constituents of forest litter and surface humus; further they destroy all vegetation that would normally cover the forest floor closely and protect the soil from drip and sheet erosion. A few scattered annuals come up each year and there are, in places, perennial shrubs that manage to survive the fires, but by the time the rains start, the forest floor is normally bare. Further, the annual fires, being ground fires, have scorched the soil severely and have pulverised the surface layer in the same way as in a *taungya*. This soil softening, in *taungya* cultivation, is one of the chief reasons for the very prolific crops that are obtained and the firing takes the place of tilling. Since the forest floor is bare and the soil has been softened by the fire, the heavy rain falls directly on the soil and is not held up at all; very little is absorbed in the soil and the greater part of it must run over the surface and it carries with it the loosened surface soil. Sheet erosion soon gives place to gully formation.

Sir Hugh Watson, in his Working Plan for the Nyaunglebin Working Circle, prepared in 1904, comments on the soil in relation to erosion as under: "On some of the exposed ridges the argillaceous sandstone is bare in patches. When shales occur the surface

soil is very shallow and gets constantly washed away by the rains. On the slopes these shales are brittle and give way underfoot and were it not for the vegetation on them, their erosion would be very rapid." In another passage on the subject of fires he says: "The necessity for fire-protecting the drier parts, such as the Pein and Nyabwa drainages and plantation areas, is not only obvious but urgent."

The erosion in the upper mixed deciduous forests of the North Pegu *Yomas* is very serious indeed. Sheet erosion is normal everywhere and is shown by numerous small turrets of earth capped with stones, dead branches and bamboos standing up on ridges of earth, eroded roots and fallen trees. The stone-capped turrets of earth are formed by drip—in all probability. To begin with, the soil is flat with a few stones embedded in it. With heavy rain dripping off a high canopy the surface soil is easily loosened, as it is already in a finely pulverised condition after the fires. The stones protect the soil they cover and as the loosened soil is carried away all round them by sheet erosion, they are left on a small perpendicular-sided column of earth. In some cases the stone is replaced by hard baked shale which has, by firing, assumed the colour and consistency of brick. To some extent the ridges of earth found under fallen bamboo and branches are deceptive. Where the bamboo lies on the ground, silt tends to collect on the upper side and this gives the bamboo a false appearance as regards the original surface level. In some cases, too, where the bamboo or branch does not touch the soil a ridge appears under it; this may be caused by drip eating away the earth on each side but, to some extent, the ridge is caused by splash.

On practically every hillside gully formation is rife wherever the slopes are steep. The extent of the erosion can be gathered from the fact that in one small area, in the Wunpein Reserve, of the total stock of teak over four feet in girth, dead and alive, 7 per cent. were fallen trees which would yield a marketable log and the major part were uprooted because their roots had been undermined and exposed by erosion. There were, in addition, very many fallen teak which could not produce a marketable log and it must be remembered that these fallen trees have mostly fallen in the last thirty years since extraction took place in 1910.

In a great majority of the stream beds there is a vast amount of silt and in places valley bottoms are silting up and are now lined with dead trees and bamboo clumps which were unable to exist under the raised level of soil. The lower stretches of these streams carry so much silt that their courses are continually changing and, were it not for the work of the River Training Department, floating of timber would be almost impossible. It is very rare in Pegu to find a stream, in the *Yoma* itself, that is not muddy and which will not become cloudy if any animal passes through it as the silt is stirred up.

The chief reason for this erosion is the lack of surface cover of undergrowth, forest litter and humus and this is chiefly due to fire There are, however, two contributory causes: the first is the maturity of the *kyathaung* bamboo. This bamboo has now formed an impenetrable canopy for at least 60 years and has killed out most of the ground cover that came up at the last flowering. As the flowering of this bamboo spreads, there will be a few years' respite in erosion, because the immediate result of flowering is a dense growth of weeds which gives the soil complete protection, when combined with the mass of bamboo seedlings. This weed growth tends to prevent fire in the moister slopes and so a fair ground cover is maintained. The second reason for the erosion is the earthquake period in 1930. The Pegu and Pyu earthquakes were centred close to the *Yoma* and the epicentre in the latter is thought to have been in the headwaters of the Pein drainage. The earthquakes caused heavy landslides throughout the *Yoma* and on the east bank of the Sittang river as well.

It is suggested that fire protection is required to stop erosion in the mixed deciduous forests. Fire protection has long been abandoned by the Forest Department as unsatisfactory because of the expense and because it was argued that fire protection encouraged the less fire-resistant and evergreen species to the detriment of teak regeneration. This may be true of those areas where evergreen forests are known to be invading but is probably not true of other areas. Teak does not regenerate and establish itself naturally in appreciable quantity in *kyathaung* forest between flowering periods. True, certain small isolated trees or groups of trees may be able to get through the bamboo, when some outside agency upsets the

balance of nature, or when a large tree falls and burns and leaves a gap, in which teak seedlings get their chance. The greatest regeneration, we now know, takes place at the time of bamboo flowering. Teak regeneration exists under the *kyathaung* as small suppressed and mutilated rootstocks that send up shoots each year and these are burnt back or otherwise damaged from time to time and yet keep on just existing until the *kyathaung* flowers. The moment flowering takes place, the teak shoots ahead and it seems probable that the dense growth of weeds will help the teak to survive without fire damage during the critical first year or two.

Under fire protection it seems probable that a good soil cover would be obtained and that this would stop erosion. Further, fire protection would stop the enormous damage that now occurs to the base of teak trees and roots. This fire damage is believed to be the start of much of the heart rot that is found at the base of teak and is certainly one of the chief reasons for girdling many undersized trees in Pegu.

It is suggested that, if fire protection does stop erosion, it would also render much of the work of the River Training Department unnecessary, because the streams would no longer carry the silt burden they now carry, and deposit, with such serious effects, on the formation of stream beds.

It seems probable that the ideal treatment of these *kyathaung* forests, subject to erosion, would be to leave them to look after themselves directly after flowering until the bamboo canopy begins to thin out the undergrowth and erosion begins to take place. From this time onwards fire protection is needed for a number of years until girdling takes place. After girdling, the area should be fired until extraction is due. The idea of firing would be to reduce the unwanted weed growth and to give teak a chance to establish advanced growth which would be in a position to take advantage of the opening of the canopy by extraction and the subsequent improvement felling.

Directly after extraction is complete and before the fire season, improvement felling should be done, care being taken to remove all inflammable material from the base of all teak, both young and old. The area should then be burnt for the last time and thereafter fire-protected until girdling again takes place.

With the first sign of flowering in the district, fire protection should be abandoned so that as much teak as possible will establish itself under the bamboo and be ready to take advantage of the opening of the canopy which the flowering will cause.

EXTRACTS

THE GROWING OF PYRETHRUM IN INDIA

BY W. BURNS, C.I.E., D.SC., I.A.S.,

Agricultural Commissioner with the Government of India

Judging by the number of enquiries received by the Imperial Council of Agricultural Research, there is very considerable interest throughout India in the possibilities of growing pyrethrum. The importance of pyrethrum as an insecticide and particularly as a means for keeping down mosquitoes is well known. The original home of the pyrethrum plant (*Chrysanthemum cinerariaefolium*) is believed to be Dalmatia. Another species, *Chrysanthemum rosea*, was also at one time used. It is not so effective as the first-named species, and is now little cultivated.

For a long time the supply of pyrethrum was almost the monopoly of Japan, the plant being grown mainly in the northern portion called Hokkaido. In recent years, however, it has been tried elsewhere and has been grown with marked success in Kenya.

Introduction into India.— It is reported that in 1934—36 the Director, Malarial Survey of India, obtained seeds from Messrs. Sutton in England and planted them at Kasauli and Karnal without success. The Punjab Government obtained pyrethrum seeds from America in 1933 and planted them at Lyallpur and Murree. In Kashmir pyrethrum has been cultivated for some time near Baramulla at an elevation of 5,000 feet.

In January, 1937, the Imperial Council of Agricultural Research resolved on further trials. A small quantity of seed was secured through the India Office from the Director, Plant Pathological Laboratory, Harpenden, England, and was distributed to provincial governments and certain states for trial. A later supply of seed obtained from Dalmatia (Yugoslavia) in the early part of January, 1940, was also distributed. The co-operation of certain private individuals was also given in these trials. Pyrethrum has so far not been a success at the following places:

Dharwar and Poona in the Bombay Province;
Saharanpur, Dehra Dun and Chaubattia in the United Provinces;
Sakrand in Sind;
Ballehonnur in the Mysore State; and
Ranchi in Bihar.

The crop has been a success at Murree (6,000 feet), Kulu (5,000 feet) and Palampur (4,000 feet) in the Punjab and in Kashmir. There are also promising results from certain parts of the Nilgiris and the North-West Frontier Province. Summarizing Indian experience so far, it may be stated with certainty that pyrethrum thrives best in a comparatively dry climate and a well-drained light soil. It is susceptible to damping off in the monsoon. The temperate outer Himalayas seem suitable for growing pyrethrum.

Punjab Experiment.—The Director of Agriculture, Punjab, informed the Imperial Council of Agricultural Research in March, 1940, that it had been decided to rent one acre of land in the Kulu Valley and a similar area in Murree in order to grow pyrethrum with the object of collecting data as to the economics of its cultivation and on the basis of the information so collected to formulate a policy regarding future work. The method of cultivation followed in the Punjab is as follows:

> The plant is grown from seed. Seedlings are first raised in a nursery and then transplanted in the field. The seed is sown in March-April. The seed begins to germinate in from 10 to 15 days. The seedlings, when about three inches high, are ready for transplanting into the permanent site. Pyrethrum can also be propagated from rooted suckers or splits of the parent plants. The suckers can be obtained from old plants which have become thick and bushy.
>
> After the land has been prepared and manured, the seedlings are planted at a distance of 18 inches each way and irrigated immediately. The land has to be kept clear of weeds and irrigation given when necessary. After the setting in of the rains no irrigation is required, and the land has to be kept well drained. In the Punjab, pyrethrum flowers after about one year from the time of transplanting; flowering starts from the end of March and continues to the end of May. The flowers are plucked when they open, dried in the sun and marketed in this form. No definite figures of yield per acre are yet available from the Punjab. However, on the average, a yield of 400 lb. of dried flowers may be expected from one acre of good pyrethrum.

The method described above is, of course, adapted to Punjab conditions. In other places a different system may be required. As regards manuring it may be pointed out that Mr. V. A. Beckly, Senior Agricultural Chemist, Department of Agriculture, Kenya, is of opinion that pyrethrum is intolerant of too rich soils. Manuring, therefore, may need to be done only if it does not effect the pyrethrum content.

Analysis of fully open flowers of pyrethrum collected from the Palampur experimental plot was made by the Agricultural Chemist, Agricultural College and Research Institute, Lyallpur. The samples showed a total pyrethrin content of 0.96 per cent.

Efficiency of Indian Product.—Samples of dry flowers from Palampur and Kulu were tested at the Malaria Institute of India, Delhi. In his letter addressed to Professor Jai Chand Luthra, the Director of Institute reported as follows:

> "Powdered dry flowers from Palampur and Kulu were separately soaked in kerosene oil in the proportion of 1 lb. of powder to 1 gallon of oil (100 gm. to 1 litre). The extract was decanted after 48 hours, the containers being vigorously shaken a few times during the interval. Tests show that the insecticides thus obtained are practically as efficient as the Pyrocide 20 mixture. In all the eight sets of experiments carried out the extract of flowers from Kulu seemed a trifle inferior to that of flowers from Palampur. 5.5 c.c. of the former extract are required per 1,000 c. ft. to obtain a 100 per cent. kill as against 5 c.c. of the latter, 5 c.c. of Pyrocide 20 mixture being required per 1,000 c. ft. to give a 100 per cent. kill of mosquitoes."

In Kashmir, experiments on pyrethrum cultivation have been conducted by the Forest and Agricultural Departments and both have got excellent results. It is understood that the Kashmir Government contemplate its extension very considerably and steps have been taken to grow this plant as a protected crop. The samples of flowers produced from acclimatized seed have shown up well in both chemical and biological tests.

In Mysore there are now over 1,000 clumps of pyrethrum growing at Hebbal. These are about three years old and only 16 have

so far flowered in spite of various manurial and other treatments intended to force flowering. Splits from flowering clumps were multiplied and these have just started flowering. Some of the seeds raised from the flowers produced at Hebbal were viable and these have been germinated and seedlings are being raised.

Best Samples.—Analyses made by the Director, Imperial Agricultural Research Institute, of pyrethrin buds and flowers from Parachinar, North-West Frontier Province, show a total pyrethrum content of 0.61 to 1.11 per cent. This is the best of the Indian samples so far analysed at the Institute but is still below the level of the Kenya samples which gave 1.36 per cent. total pyrethrin. The Government Entomologist, Coimbatore, in a letter dated 14th February, 1940, reported on the insecticidal effect of three samples of pyrethrum obtained from three different localities on the Nilgris, viz., Emerald Valley, Sim's Park and Kotagiri. These were powdered at Coimbatore and tried against caterpillars of *Prodenia litura.* The material from Kotagiri was also used against caterpillars of *Plutella macullipennis,* a pest of cruciferous plants. The results of the trials are given below:

Name of place	2. *Trial (30th November, 1939)* No. of caterpillars tried	No. of caterpillars dead	Percentage of mortality	2. *Trial (6th December, 1939)* No. of caterpillars tried	No. of caterpillars dead	Percentage of mortality
Emerald Valley ..	45	10	22	25	12	48
Sim's Park	32	8	25	25	5	20
Kotagiri	42	24	57	25	19	76
	100	100	100			

It can be seen from the statement that the material from Kotagiri has caused the highest mortality in the trials. It may be stated in this connection that the insecticide was used as soon as it was received, while the others had to be kept for two months for want of insects on which to conduct the trials.

There is now enough evidence to show that pyrethrum will grow in certain areas in India. What is needed is organized expansion of production and marketing with a chemical check on the pyrethrin content to ensure of the material being effective. The production of seed also needs attention.—*Indian Farming* Vol. 2, No. 2, dated February, 1941.

A NEW TYPE OF MECHANICAL CONSTRUCTION IN THE STEM OF *PANICUM PUNCTATUM* BURM

By Girija P. Majumdar,

Department of Botany, Presidency College, Calcutta

Monocotyledons are particularly characterised by an extraordinary degree of variation in the types of mechanical construction of their inflexible organs. Schwendener noted 28 types of such construction in this class alone, and arranged them into a number of mechanical systems. But the type under discussion has not been reported, so far as the writer can find out, by Van Tieghem, Schwendener or Haberlandt. As a detailed report on the anatomy of this plant will form the subject-matter of another paper, only the mechanical construction of the adult stem is described here.

The epidermis and one or two hypodermal layers have their walls thickened and lignified to form the hard rind characteristic of the grass family. The subhypodermal ground tissue is characterised by the presence of a ring of air cavities which run in longitudinal rows through the internode. The vascular bundles are arranged in radial rows at regular intervals occupying the regions between successive air cavities the largest bundles being always towards the centre of the stem. The stereome runs in the form of an inverted arch encircling more than half of each air cavity on the inner and lateral sides and joining firmly to the top of the vertical pillars built up of the composite girders formed by the bundles in each row. The centre of the stem is occupied by a big cavity formed by the disorganisation of the pith cells.

The plant grows in water and mud and is subjected to lateral compression and bending. In this case the mechanical construction, it appears, has been followed on the principle of the construction of

a suspension bridge instead of that of an I-girder. A suspension bridge "consists of two or more chains constructed of links connected pins or of twisted wire strands, or of wires laid parallel. The chains pass over lofty piers on which they usually rest on saddles carried by rollers and are laid down on either side to anchorages in rock chambers." Thus in a suspension bridge three things are necessary, viz., *lofty towers* over which the *wire ropes* of very great tenacity pass, and the *massive anchorage*. The lofty towers in this case are the vertical pillars constructed on the girder principle, the wire ropes are the continuous inverted arches of stereome and the anchorage, instead of being local and massive, is more efficient and economical in the fact that the stereome is continuous round the stem in the form of a wavy ring passing at definite intervals over vertical towers. When compressed due to a temporary load (stress) any deflection is resisted by the stereome tissue as a whole.

What is considered a defect in a suspension bridge, i.e., its flexibility, is in fact a necessity in the stem of these plants. As regards the material of the wire ropes, iron and steel of the strongest form are used and the tensile strength of sclerenchyma cells, of which the stereome is constructed, is equal to that of wrought iron (15—20 kilograms per sq. mm.), and in some cases "vies even with steel in this respect." Its strength increases with diminishing water contents, while its elasticity is correspondingly diminished, making the older parts of the stem more rigid than the younger ones.—*Current Science*, Vol. 10, No. 5, dated May, 1941.

BIBLIOGRAPHY

1. G. Haberlandt, *Physiological Plant Anatomy*, Eng. Ed., 1914.
2. S. Schwendener, *Das Mechanische Princip im Anatomischen bau der Monocotylen*, 1874.

PULP AND PAPER

RESEARCH WORK AT DEHRA DUN

All the member mills of the Indian Paper Makers' Association now have a very practical interest in the work of the Paper Pulp Section of the Forest Research Institute, Dehra Dun. The mills have agreed to a voluntary cess of four annas per ton of output, based on audited statements of the production of the mills, in order to help to finance the cost of undertaking research work to be carried out in the general interests of the industry. When this arrangement was made it was also agreed that an advisory committee should be formed to act as an advisory body to the Forest Research Institute in matters of research undertaken of its own initiative and also to control and supervise the prosecution of research and other scientific work of general utility and importance to the existing pulp and paper mills. Mr. R. W. Mellor, Mr. C. A. Carmichael, Mr. J. C. Lowe and Mr. Karamchand Thapar were appointed as the representatives of the Indian Paper Makers' Association on the committee and the first meeting was held in Calcutta on Saturday, March 8th, under the Chairmanship of Mr. S. H. Howard, I.F.S., who is President of the Forest Research Institute and also Inspector-General of Forests to the Government of India. Mr. M. P. Bhargava, Officer-in-Charge of the Paper Pulp Section at Dehra Dun, was also present as the second official member nominated by Government. At this meeting, *inter alia*, the committee discussed the triennial programme of the Paper Pulp Section of the Institute and came to certain decisions regarding the more important and urgent problems which should be given priority in the investigations of the Paper Pulp Section Staff. One of the technical problems it was agreed to investigate related to the possibility of devising means to remove the silicious scale occurring on the surface of bamboos which appears to be unaffected by digestion or bleaching and which is considered to be one of the primary causes of dirty bamboo pulp. It was arranged that a small technical sub-committee should be formed in conjunction with Mr. Bhargava to consider the adoption of a scheme to standardise tests and testing apparatus for paper and pulp and also to consider standards for testing the various raw materials found in India. Other important decisions were made, one to produce a scheme to make it possible

for workers in paper mills to obtain an elementary diploma in paper technology and another to build up a reference library at Dehra Dun containing up-to-date technical publications dealing with the paper and pulp industry. The above proposals are, of course, subject to the formal approval of the Government of India, but it is hoped that their approval will be forthcoming at an early date, and that work will be started forthwith.

The Paper Pulp Section has been working for some years now on problems which specially affect Indian paper mills, and has recently submitted reports on:

1. The discoloration of pulps.
2. The preparation of bleachable kraft pulp.
3. Testing of pulps and raw materials from various mills.
4. The production of mechanical pulp from soft white woods.

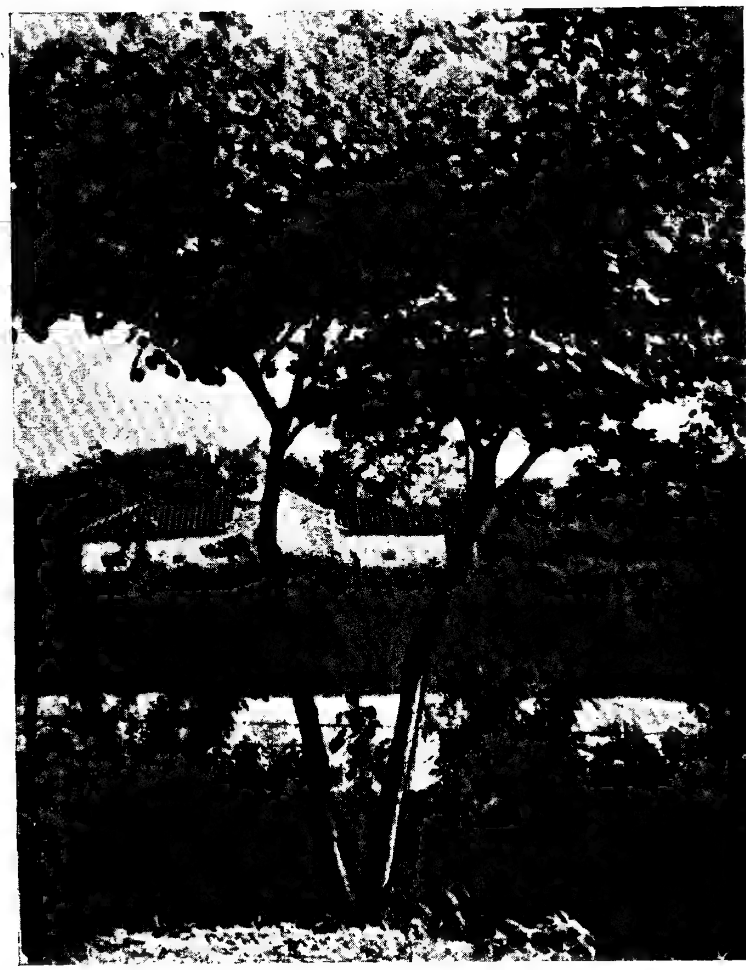
There is no doubt that the work of the Institute which has already been of great value to the industry for some time will now receive a fresh impetus by the real interest shown by all the paper mills in the country as a result of their mutual agreement to support and encourage the research work by voluntary contributions.—*Indian Print and Paper*, Vol. 6, No. 4, June, 1941.

VOLUME LXVII 501 NUMBER 10

INDIAN FORESTER

OCTOBER, 1941

"ZEITGEIST"



By—K. P. Sagreiya.

"V" FOR VICTORY

Even the Trees have imbibed the "Zeitgeist."

A

SOME ASPECTS OF THE PROBLEM OF *TAUNGYAS* IN BURMA

BY D. E. B. MANNING, I.F.S.

It is generally recognised that *taungya** cutters are amongst the poorest people in Burma. There are a number of reasons for this poverty. The first is that when a man has lost everything he can still earn a very precarious living by cutting a *taungya*: as a result all those who have failed to make a living at farming or as coolies or some other trade finally settle down to *taungya* cutting. To start with, therefore, the normal *taungya* cutter is the poorest and generally the laziest and most ignorant of the population. Should he by any chance make anything by a combination of cooly work and *taungya* his ambition is to get fields and settle down to permanent cultivation. These comments do not apply to the hardened Karens of the Yomah whose ambition it is to live as their fathers did, cut off from civilization and progress.

With the increase in population it is becoming increasingly difficult for the *taungya* cutter to find any land to work by regular cultivation, since most of the land suitable for regular irrigated cultivation has already been taken up.

One of the reasons for the very meagre return that *taungya* gives is the ignorance and laziness of the cultivators. At the best they just make enough to keep them in a good year; most years they fail and have to get work as coolies to enable them to buy enough food for the year. They have their normal *taungya* crops which have probably not altered at all for literally centuries; any new crops are looked at with suspicion and new methods are never introduced willingly.

There seem to be two main possibilities for the improvement of the living obtained from *taungya*; the first is to improve the volume, variety and quality of the crops and the second is to improve the land so that a more stable form of cultivation is possible.

The *taungya* cutter has only a passing interest in the area he cultivates and the reason for this is that although he pays *taungya* tax on his cultivation, he never acquires any landholders' or other rights in the area. This being the case, he selects the richest bit of

**Taungya* means hill cultivation after cutting and burning.

the forest he can find, cultivates, gets what he can and then abandons it. In thickly populated areas this selection of the richest area for *taungya* results in a vicious race to lay waste the better soils before anyone else can do so. The *taungya* rotation in densely populated areas may fall as low as three years. The evils of frequent *taungya* cutting are too well known to be worth repeating but the result of repeated cutting is, briefly, that the soil is rendered infertile by the exhaustion of vegetable and mineral content and this is brought about by the firing, dessication and erosion.

Another drawback of the present legal position of *taungya* land is that *taungya* cutters cannot form a permanent village because the land they might hope to work can be worked by anyone who desires to work it. Planned rotations with a central village are thus almost impossible. With temporary villages and scattered hamlets that are moved each year social intercourse and the accumulation of wealth and a decent standard of living are impossible. *Taungya* cutters are hard to move once they have had a good crop because their paddy, often a hundred baskets or so, has to be moved over hilly country and carting is often impossible. As a result *taungya*s are often cut in country that is not really suitable because the work involved in a long move is too great.

The question of crop improvement is now being taken up by the A. B. M. Agriculture School at Pyinmana and some very useful crops have already been evolved, the most readily appreciated by the *taungya* cutter being *pelun*, the "New Era Cow" pea. This provides an excellent cold weather crop after the main rice crop is reaped. There remain to be demonstrated satisfactory crops for the hot weather and second year.

The other method of improving the *taungya* position is the improvement of the land. The normal *taungya* land is hilly and, for that reason mainly, cannot be cultivated permanently for paddy under present methods. A further reason is that even if some of the hill land could be brought under permanent paddy cultivation, water would be a difficulty in some cases.

The first requirement of any land improvement scheme is that there should be some form of ownership of the land; no one will waste time in improving land if the only benefit he will get is a

crop for a year or two. To this end it is suggested that the payment of *taungya* tax should gradually build up rights of ownership in the land. If this were to be coupled with grants from Government for the efficient terracing of the land it would be possible, gradually, to get *taungya* lands held by people with an interest in their improvement and fertility.

Terracing makes rice cultivation possible on the steep hillsides in Java and there seems to be little reason apart from cost, why it should not also be possible in the hilly lands of Burma at present *taungya* cut. The main difficulty might be water supply and where this is serious the most desirable thing would be to have dry cultivation. The rice market already takes as much as it can and some other form of produce seems very desirable.

Having got terraces and the possibility of permanent cultivation on hillsides it would remain to finance the poorest class of *taungya* cutter so that they could buy cattle to do the necessary ploughing.

The trouble in Burma is that this question of hill cultivation interests no one. The Agricultural Department deals with lowland cultivation and has not the staff to take on anything more; the Forest Department has still to awaken to the fact that erosion of the hill country is a vital factor that must be dealt with, while the general public knows nothing of what is going on, away from the main rice fields.

At the moment our knowledge of this serious problem is negligible. We do know that continued *taungya* cutting results in progressively poorer returns in crops, with heavy erosion. We know also that there is growing land hunger and that increasing numbers of people must turn to cultivation of the hills as the population increases. With this inevitable problem before us it seems obvious that the sooner we start considering scientific cultivation of the hillsides the better it will be for the country. It is clear that without proper cultivation the hilly country gradually deteriorates into wastes of *beezat** and grass with serious annual fires and such heavy erosion that finally the land is fit for nothing. With the increase in population it is clear that every available acre of hill land adjacent to the large centres of population must eventually be cultivated.

---

*Beezat = *Eupatorium odoratum.*

The first thing that must be done is to prove, by demonstration, that some improved method of hill cultivation is possible. Demonstration and experiment must be started before the demand becomes too heavy so that the work can be carried out without being rushed. To prove a case we must have facts and figures and the sooner we start collecting these the sooner shall we be in a position to put forward a case for improved cultivation of hill land.

Terracing seems at the moment the only possible way of keeping the fertility in steep hillsides under annual cultivation. It remains to be shown if this can be done efficiently and economically. Having stabilised the land by terraces, how is it to be cultivated? There seems a possibility with the very impecunious type of cultivator who is driven to hill cultivation that *taungya* may still have to be used for a number of years. The ideal *taungya* is one in which all the large trees have long since been felled and which is a mass of small trees and bamboo. Supposing a *taungya* of this type were situated on terraced land, would *taungya* on a fair rotation, with no soil losses owing to erosion, be an economic proposition? Suppose each cultivator had 50 acres of hill land allotted to him and he *taungya*-cut and terraced five acres a year. He would in the second rotation have an annual five acres of terraced land to *taungya*-cut and gradually to bring into permanent cultivation. He could take in a further five acres each year and, there being no soil losses due to erosion, he would gradually have a permanent agricultural holding. Perhaps the areas are too large and $2\frac{1}{2}$ acres only per year might be taken in hand but, even so, an area of some 30 acres would gradually be made into permanent agricultural land.

The terracing would need Government loans and it would be necessary to safeguard such terraced land from neglect. The possibilities of adding a very large area to the agricultural land of Burma seem good, but it remains to be demonstrated that terracing does solve the problem at an economic figure. Is it essential that the costs should be at an economic level or is the importance of providing land and stopping erosion so great that figures of profit and loss may be disregarded?

The problem is immense and the urgent need of the moment is to start experiment and demonstration so that we may know as soon as possible what can be done and how it can be done.

REGENERATION OF SAL *DE NOVO* (A CRITICISM)

BY Y. R. DIVEKAR

It was a night in early June. Fireflies glowed and quivered on a *Cassia* tree until it looked like a bower of phosphorescent light. Presently a big tusker passed by the tree; followed other elephants, big and small. Said the leader of the fireflies, "Whoever saw these big blundering brutes pass by this tree before by night? It is our light that shows them the way and draws them out on such a dark night." "Of course! Of course!!" cried the other fireflies in chorus and quivered with pride until there was a blaze of phosphorescence.

This fable is on a par with the claims made for contour trenching and its alleged power to attract rain.

This year Peint registered more than 40 inches of rain in four days, over 18½ inches being recorded on a single day. Dharampur went one better and had over 38 inches in 24 hours. In Kalyan boats had to take people about in the main street of the town. These facts are such that any one with a scientific turn of mind will be humble enough to admit that our knowledge of the meteorological factors which cause precipitation in any particular locality is most meagre.

It is not the amount of water evaporated from a given surface that is responsible: otherwise Sambhar Lake must have more rain than Cherapunji. Nor is it "saturated" atmosphere, since otherwise Mahabaleshwar would have less rain than the moist Konkan coast. No. Let us in all humility admit that there are more things in the meteorological heavens than are dreamt of in our "contour-trench" philosophy.

Let me not be misunderstood. We are all grateful to Mr. Warren for being the pioneer in India to start contour-trenching and to show us how to conserve moisture on hill slopes in arid areas. But making any wild claims on behalf of contour-trenching that are not warranted by the facts is only to invite ridicule on an otherwise perfectly sound theory and practice. We have all heard of the dentist who wishes to pull out all your teeth and give you a new artificial set in order to put an end to all your digestive troubles in future: also of the surgeon who believes that the only way to make

a man of yòu again is to chop off your appendix. Surely this is not a rôle which we are anxious to play.

Newton waited years before publishing his theory of gravitation because somebody had made a mistake in the calculation of the distance of the moon from the earth and he thought that all the "facts" did not square with his theory. Is it too late for us to learn this scientific restraint before rushing into print with our "conclusions?"

EXTRACT FROM THE KING'S ENGLISH DICTIONARY

BY "RICARDO"

"VERBIAGE—*n.* (Latin *verbum,* word), *the use of many words without necessity.*"

Some months ago I heard on the wireless from the lips of a very entertaining news commentator, Mr. A. G. MacDonell, that the Prime Minister of England had ordered the substitution in Government correspondence of such ponderous phrases as "The answer is in the affirmative" or "I regret to have to inform you that having due regard to the circumstances of the case the answer is in the negative" by a plain "yes" or "no." No doubt these orders were issued with a view to economy of paper and time but mainly, I feel, on the grounds of commonsense. What a magnificient precept Mr. Churchill has set for the East and why isn't it followed? The days of high-sounding, long-winded and laborious language are over and should have passed from the East with Lord Curzon. Unfortunately, they haven't.

"Verbiage," I think, can be divided into two classes: (*i*) the use of many unnecessary words to express something pertinent that could be equally well expressed in a few words, and (*ii*) the use of many words to propound something which could just as well have been left unsaid altogether.

The examples given by Mr. MacDonell illustrate the former class; the following examples illustrate the latter:

For some years now Game Rangers have been allotted to my division for the purpose of destroying wild elephants, which raid

village crops and upset village life generally. For an equal number of years my accounts have shewn bonuses paid to Game Rangers for the elephants they have destroyed. Suddenly the "Prime Minister of Verbiage" took exception to one such item in my accounts and enquired: "Please state how the carcase was disposed of."

Now, I could have given many answers, all more or less truthful. I could have said "By ants," or "By tigers." What I actually replied, however, was "It was eaten"—and that satisfied him. It had the merit of being true too. I was quite sorry he didn't ask "By whom?" as I should have replied, "The Divisional Forest Officer."

But that is not all. A month later he objected to an item in my accounts showing the purchase of a tin of coal-tar for marking standards. "Please state how the tin was disposed of." I referred this to my Conservator as being a frivolous objection, and I am glad to say he rose to the occasion and replied to the "P.M. of V." that such tins usually find their way into the outhouses of Forest Rest-Houses, where they are filled with sand for a specific purpose.

There is another case which was told me some time ago. A Divisional Forest Officer bought a box of paints for the use of his draftsman. The "P.M. of V." objected and asked: "Please state to what purpose the box of paints is to be put." The Divisional Forest Officer replied: "To paint with"—and heard no more!

You can probably quote dozens of other similar cases. They are all rather amusing and I know it is a good thing to let a little humour enter the daily routine.

But the point I am trying to make is this. The Fiscal Committee say, and apparently Local Government agree, that there should be drastic curtailment in most branches of the public services. Here surely is the first cut to be made. Verbiage is a disease which, like other diseases, if left unchecked, will grow to such an extent as to cause the death of its host. It must be tackled at its source in order to effect a cure. Eliminate the begettors of "VERBIAGE—*the use of many words without necessity*." For without this elimination the Services will never find time to get on with their proper job.

"AND SHALL EVER PRAY"

"RICARDO."

THE JHOK FOREST

BY G. D. K.

Along the banks of its river the Punjab possesses a large number of small forests, locally known as *belas*. Scattered here and there they do not appear—when considered one by one—to be of much use but, in their total area of 15,000 acres, they really form a very valuable estate.

Belas are situated on alluvial riverain land subject to annual or periodical flooding, and contain scattered groups of *shisham* (*Dalbergia sissoo*), *kikar* (*Acacia arabica*), *phulai* (*Acacia modesta*) and mulberry (*Morus alba*) mixed with shrubs and grasses. Much of the land is covered with *kana* grass (*Saccharum munja*) and *pilchi* (*Tamarix dioica*) and is too low-lying to produce anything more than revenue from grazing.

Not much has been done yet to bring these *belas* under regular forest management but the little that has been done has been very successful.

Experiments to stock them with pure *shisham* were started in Jhok forest near Lahore in 1871, and by 1880, 1,562 acres had been afforested at a net cost (after deducting revenue from grazing and temporary cultivation) of Rs. 5-12-0 per acre. Since then these 1,562 acres have been properly thinned and tended, and the result of the work can be judged by the excellent profits made up to date. In 1924, when fellings under the first working plan were begun, the revenue from the sale of thinnings, dead trees, grazing, *sarkana* grass, etc., had been sufficient to pay off all the capital cost and leave Government a net profit of Rs. 1,78,520 and a growing *shisham* forest valued at Rs. 4,84,220. Over the 70-year period of its life (1871 to 1941) this "comic" little *bela* has probably given as high a net annual revenue as any other forest in the Province, for the net surplus on its 1,562 acres over these 70 years has been Rs. 8,71,502, equal to Rs. 8 per acre per annum. In these enlightened days, when forests are judged by the amount of gold and not the amount of timber and firewood, etc., which they produce, Punjab foresters ought to be quite pleased with their little *Jhok*.

REVIEWS AND ABSTRACTS

SOIL CONSERVATION

By H. H. Bennett.

McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W. C. 2.

Here is a book on which every politician and every schoolmaster ought to pass an examination before being permitted to take up his duties. It should be prescribed as a text book in every college and for every administrator. On its contents every Indian patriot should preach sermons unceasingly. It drives home, with words and illustrations, lessons which India must learn, and learn quickly, if she wishes to become healthy and happy. "The potential wealth and living standard of this nation, or of any nation, depend ultimately on its store of natural resources. If, through carelessness or neglect, these resources are wasted, the whole structure of national achievement must be impaired." The examples given in this book are mostly from America but its lessons are applicable everywhere and its points are emphasised by a historical survey of erosion and civilization throughout the world. How frequently man's conquest of the land has been disastrous, resulting in extreme impoverishment or complete destruction of the soil upon which he is dependent, with the consequent disappearance of civilization from the affected region, archæological evidence in Africa, the Near East and Central Asia shows only too plainly. Yet man still goes unheeding on his wilful way.

The progress of agriculture is briefly traced from the deltas of the Tigris and Euphrates rivers, concerning which the earliest known writings are stated to date from about 3000 B.C., through Palestine, Phœnicia and Syria to Greece, Italy and Northern Africa. Everywhere these lands show a lower proportion of forests than their climate and mountain configuration would suggest as normal and everywhere erosion of the highlands has been accompanied by sedimentation along the lower river courses, floods, destruction and barren acres. There is an interesting account also of the highly

efficient methods of soil conservation developed by the Incas and their predecessors on the steeply sloping lands in Peru. The elaborate system of stone walls 8 to 14, or even 50 feet high, was combined with hand-filling of soil and irrigation by aqueducts, bringing water from sources often miles away. Where necessary, these aqueducts were paved with stone or cut in the solid rock. The investment of human labour on such enterprises has been estimated as reaching fabulous proportions, even as high as 18,000 dollars per acre on the basis of present American labour prices. Even by means such as these, permanent agriculture has, where necessary, been achieved. It is the function of this book to show how simpler practices, undertaken in time, can establish similar results. It also demonstrates the fatal consequences of wrong methods in agriculture, which permit erosion of the soil.

This book tells how, in the beginning, as the adventurous settlers in the New World hacked down the forest and drove their ploughshares deep into the earth, or spread their herds over the ranges, they did so in the faith that they were creating a land of liberty; a land where there would be opportunity and independence and security for any man. It tells also how the goodness of the land, which made it possible to realize that magnificent dream, has been plundered, degraded and utterly ruined. Fifty million acres of land formerly under crops almost entirely abandoned because it has been so stripped of its top soil, or so cut up by gullies, as to be economically unworkable. Another 50 million acres definitely going the same way and bordering on a condition of practical uselessness. In addition, about 100 million acres severely impoverished and in urgent need of recuperative action. An estimated total of some 282,000,000 acres ruined or severely impoverished and an additional 775,000,000 acres being affected by erosion at the present time. Measurements indicate that at least 3,000,000,000 tons of solid matter are washed out of the fields and pastures of America every year. These are stupendous figures, but the fact that they have been collected does show that the problem which they represent in America is realised and the scope of the danger is appreciated. More important still are the measures, fully explained in this book, which are being adopted to deal with this disastrous condition.

How do we stand in India in this matter? The voices of a few prophets have been raised in the wilderness, but they are still practically unheeded. Even a glance at many of the more than 350 illustrations in this book will show scenes of destruction strongly reminiscent of many parts of India. Soil erosion is undoubtedly one of India's major problems. It may even quite possibly be worse here than it is in America. Yet even the preliminary stage of assessing the general scope of the problem has not been attempted yet in this country. How much longer will lethargy and *laissez-faire* allow this peril to continue to spread in our midst?

E. A. G.

EXTRACTS

HEADWATER HIGHWAYS—A NEW FOREST MENACE

By Bernard Frank

U. S. Forest Service

Although few specific data are available on the subject it is clearly evident to the casual observer that highway construction in headwater areas often accelerates run-off and erosion. Many readers undoubtedly will disagree with some of the author's arguments. The article, however, should stimulate interest in what probably already is an important problem, and one that will become more serious as additional highways are constructed.

On one-sixth of the country's area, forest cover is of major influence in the control of waterflow and soil stability. On this portion the forester's foremost responsibility concerns the water resource. But the soil and cover conditions governing the quality of this resource are far below normal, in spite of a growing demand for flood reductions and dependable water supplies.

In managing such lands, foresters have yet to demonstrate a sufficient regard for the effects of cover disturbances on the delicately balanced relation of soil and water. Floods are naturally fostered in these headwater regions of thin, erosive soils, with slopes around fifty per cent. and stream grades up to twenty or more. The greatest caution, therefore, is demanded in any undertaking which might tend to disrupt unduly the continuous pattern of the vegetative cover or to weaken its protective influence.

This is especially necessary in view of the still limited knowledge concerning the permissible extent of cutting or grazing on mountain slopes, consistent with optimum water delivery and with sufficient control over destructive soil and water movements. Timber and range practices are gradually being improved on at least the 122,000,000 acres of major watershed influence in public control. Such practices, however, meet only part of the requirements for good watershed management. Good watershed management requires more than fire protection or conservative cutting or range practices. Good watershed management dictates that all preventable disturbances to cover and its vital soil and water relations be avoided or kept to the minimum.

One serious cause for such disturbances is the headwater highway. The damaging effects of this fairly recent development have in many instances cancelled the beneficial influences of the vegetative cover. Indeed, the increasing tempo of such road-building constitutes a real threat to any satisfactory water resource management. And now the grave truth appears that the forester, in permitting or condoning a sporadic and unthinking layout of roadways in his forest precincts, has been clearly derelict in his responsibility.

Improper or unjustified road construction in forest areas has filled reservoirs, destroyed water-spreading grounds and irrigation works, choked stream channels, wiped out recreation sites, depreciated farm lands and urban properties, ruined fishing in hundreds of miles of mountain streams, and seriously impaired priceless scenic resources.

IN THE GREAT SMOKIES

One of the clear-cut examples of the destruction wrought by road construction in important headwater regions is the Skyline Drive in the Great Smoky Mountains National Park. This road,

completed in 1936, traverses for its entire length of seven and a half miles a virgin spruce-fir stand intermixed with yellow birch, beech and oak. Observations in March, 1938, showed that within the previous 18 months, some 1,900 trees, ranging in diameter from 2 to 34 inches had died, broken, or fallen. Damage to spruce and fir was in proportion to their distribution indicating an equal incapacity to resist wind and desiccation when suddenly exposed. Water from the previous day's heavy rain, carrying considerable quantities of silt, was running freely down the upper slopes of the road cuts. The down-slopes, however, were practically devoid of moisture, the water being concentrated in the road drains, causing the strips of timber between to dry out. (2)

A re-examination of this road stretch in July, 1940, established that the rate of deterioration is increasing. Since 1938 the forest margin has receded from 50 to 150 feet on the upper slopes, and up to 50 feet on the down slopes. Practically every section exhibits the ravages caused by the construction of this road; windfall, dying tops, bank erosion, slides, and practically complete destruction of timber on spur ridges along the major curves. Hardwoods, previously affected only slightly, now show unmistakable signs of injury. All this despite continuous remedial efforts. Such coniferous reproduction as has been established is sickly, and clearly ill-adapted to the xerophytic site conditions artificially created.

ELSEWHERE IN THE APPALACHIANS

The damaging effects of road construction are observable elsewhere throughout the Appalachians. In the Pisgah National Forest, the widening and extension of the state highway along the face of the cliff up Lookingglass Creek to Pisgah Ridge has filled the channel with debris, destroyed the hemlock bottom immediately below Lookingglass Falls and deposited so much sand in this formerly clear stream as to ruin it completely for fishing. Similarly, silt produced by widening the Yellow Gap forest road in the same area is steadily destroying the fishing in the South Mills River. Factors in both these situations, especially in Lookingglass Creek, have been the unnecessary and injudicious use of dynamite and the failure to take into account the effects of road cuts and sudden exposure of soil

on siltation and run-off. Yet both these roads were designed to make more accessible the previously excellent fishing streams and unique scenic attractions of the territory.

During the storms of August, 1940, numerous slides, some unusually large, occurred along the Blue Ridge Parkway and other major highways in North Carolina, resulting in the deaths of four persons.* Much of the bank mulching and seeding applied so painstakingly along sections of this drive in both Virginia and North Carolina has been washed out by the August and September rains, road banks deeply gullied and exposed to the hazard of further slides, and road ditches completely filled. Silt and debris have already found their way into formerly clear streams and will continue to do so for some time to come. Similar cases may be cited for almost any major road, and many minor ones in the mountainous sections of these and adjoining states.

IN THE WEST

Such conditions are by no means peculiar to the East. The classic and most spectacular example of the damaging effects of mountain road construction in the West is the Angeles Crest Highway in Southern California. The San Gabriel Mountains which this road traverses are characterized by shattered, rotten rock, numerous fault lines and a high rate of geologic erosion. Recent studies show that the debris movement from slopes along this and other mountain roads in Southern California averages 125,000 cubic yards per mile as compared with the maximum of 500 cubic yards from roads through the valleys. Discharge rates per square mile range upward from 1,500 cubic feet per second as against 100 cubic feet per second maximum discharge in the agricultural sections below. Considerable damage to downstream properties is naturally to be expected under these unstable conditions. A study conducted by the Forest Service in 1934 showed that the debris from the Angeles Crest Highway reduced the capacity of the Devils Gate reservoir by 11 per cent. in 14 years, and was the major cause of the destruction of recreational developments in the Arroyo Seco canyon during the

* *N. Y. Times*: 16 dead in floods, South's loss heavy; August 15, 1940, and *Asheville Citizen*: Boone area reports 13 dead, 3 missing; August 16, 1940.

floods of March, 1936.(3) It is significant that this drainage had not been burned over in years, and that, except for the highway, the slopes were well protected by a good chaparral cover.

"Another result," according to this study, "even more serious from the economic standpoint is a long train of damages from erosion beyond the rights of way for which the new roads are almost invariably, although by no means unavoidably, responsible.

"The direct cause of all this damage is, of course, the movement of enormous quantities of soil and rock which are loosened during construction and start on a sudden accelerated descent to the sea. A great part of this displaced material finds its way almost immediately into the stream channels, reservoirs, waterspreading grounds and irrigation works. The damage to water supplies created by such deposits has in some localities reached serious proportions." In many cases, the action of flood waters and debris from road slopes is "similar in every respect to a major flood from a burned area."

It is quite probable that the Angeles Crest Highway and even some of the minor roads in the San Gabriel formation will never become fully stabilized no matter how well the slopes are supported by retaining walls or the road banks wattled, mulched, and vegetated. Proper engineering and vegetative measures, along with intensive fire control to protect the vital soil binding cover, undoubtedly will meet the immediate problem of excessive precipitation. But in view of the prevailing geologic conditions, large segments of these roadways may easily be erased by land slips and considerable damage caused to valuable downstream properties already dangerously exposed to high flood hazard.

Studies of reservoir siltation in the San Francisco peninsula, a region of hilly terrain, show that the major cause of sedimentation is state and county highway construction. Road cuts vary from three to nearly 70 feet. By far, the most serious erosion is that caused by sliding and slumping. One of the major cuts, 50 feet high and very steep, produced a slide of over 200 cubic yards. It is almost impossible to reduce the gradient of this slope in view of its length and steepness and the large amount of material involved; consequently, it will continue to give rise to slides.(6)

Rains of near cloudburst proportions during September, 1940, caused the blocking of many miles of road by slides on the Payette National Forest in Idaho. These mud and boulder movements occurred on slopes weakened in many cases by road cuts. Large sections of earth were loosened above many sections and on one road, slides occurred at every drainage in the upper portion of the watershed.*

Roads built at intermediate elevations in northern New Mexico and Arizona are likewise subject to recurrent slides. When cleaned out these slides become drainage channels. As water concentrates in the depressions, they deepen, widen, and creep steadily up the mountainside until eventually they reach back to the crest of the slope far above the roadway. As sources of mud flow, particularly after summer thunderstorms, such slides are responsible for heavy stream silting and flood plain deposition, making the problem of downstream flood control all the more difficult.

IN PUERTO RICO

As another illustration of how road construction aggravates land slips and impairs watershed values, the high standard recreation-administrative road in the Sierra de Luquillo in Puerto Rico may be cited. "Because of steep slopes, rock faults and cliffs, thin mica-filled soils that get as slick as soap when wet, land slides and washouts presented many engineering problems, especially on the road traversing the National Forest. . . . That the scenic and climatic advantages of the area open to the public justified its construction is evident."(4)

Granting the pressing recreational needs of the dense population tributary to this area, one is compelled to ask if in constructing this road sufficient study was made of local geologic and soil conditions to indicate whether an alternate road location, a simpler design, or the restricted use of blasting in favour of other methods would have been less inimical to the stability of these slopes.

WHERE NOT TO BUILD ROADS

Many roads in high mountain areas or in other regions of unstable geology or ecology have undoubtedly been justified by

* "Boise Capitol News," Boise, Idaho; 19th September, 1940; "Rain Ruins Roads."

growing requirements for recreational use, fire control and general transportation. On the other hand, the far reaching consequences of such construction, remedial measures notwithstanding, makes it necessary to propose that in our basic road planning we also consider where *not* to build roads as well as where and how to build them. It is in this aspect of the problem that the forester needs to assume a more positive role. What little consideration he has previously given to this question has been limited chiefly to zoning against roadways of wilderness, wild, and other natural areas.

In such cases it has definitely been recognized that road building, and the intensive recreational use and developments following it, would destroy the scenic and spiritual values such areas are intended to perpetuate. The fact that such zoning has also been alvantageous to watershed stability was probably only of incidental note. But if foresters are properly to fulfill their responsibilities in land management, they need to devote much more serious thought to the many other situations in which road construction should be avoided or materially modified.

ECOLOGY AS BASIS FOR POLICY

The limitations of road construction may be better understood by reviewing briefly the ecological relations underlying the formation of the climax stage in plant succession. It must be recognized at the outset that the course of development of the complete plant community, particularly at the higher altitudes, is at best long and slow, and subject to constant interruption by a wide variety of elemental forces. Under the severe climatic conditions obtaining, long periods, sometimes centuries, are required to build up a tough wind resistant and moisture absorbing and retaining cover. The interaction of cover and environment are succinctly stated by Lowdermilk(5): "The patterns of natural vegetation and of undisturbed soils represent the responses to the prevailing climatic conditions of the recent geologic past. In like manner, the geologic norms of erosion and the regimen of streams are adjustments after thousands of years to the prevailing character of geology, topography, climate, and vegetation."

In this process, the forest floor, ground cover, understory and overstory become a biologic entity, every component part of which

is mutually dependent for its effectiveness and survival on the rest. Adaptability to the rigours of the environment well nigh reaches perfection and an almost ideal soil protective and moisture retaining forest cover results. In turn, the vegetation so modifies temperature, humidity and wind action as to produce a characteristic local climate. This state of balance, however, is dynamic and may easily be upset by any one of a number of internal or external disturbances. Openings in the dense canopy caused by fire, by slides, by insect or disease epidemics, by hurricanes, or other severe climatic or geologic phenomena may at times become so enlarged as to threaten ultimate destruction of the entire cover complex.

The ruin of the overstory itself is only one of many adversities suffered in the chain of destructive forces thus set in motion. As the stand is opened up to wind and sun, the litter and humus deteriorate and the mineral soil is exposed and subjected to significant chemical changes. Since precipitation is intense and erosion and run-off potentials are normally high in mountain areas, soil and water movement are immediately accelerated. Excessive drainage rapidly deprives the stand of its vital moisture supply, weakening it still further. Wind action against the unprotected crowns and stems of the marginal trees leads to blow downs and further desiccation at all levels. Where old growth conifers dominate, particularly such species as spruce, the true firs, western red cedar, western white pine, hemlock, and even some deciduous species, the stand may be wiped out entirely.

So long as the forest floor and undergrowth are not directly destroyed, the remaining vegetation may adjust itself to the altered environment and together with invading species gradually rebuild the protective cover. But under certain critical conditions, especially where the ground cover has been suddenly and completely removed, the water table tapped, and the slope continuity broken, as by clearings for rights-of-way and by cuts, the rate of devastation may become so rapid as to defeat natural or even artificial attempts at restoration. In many head-water areas as much as 50 years or more may be required for the re-establishment of any type of protective cover, and far longer to restore the former plant-climate complex.

The basic ecological problems involved in such situations are well recognised in the reclamation work undertaken by foresters abroad and at home. In Holland, outstanding success has been achieved in stabilizing sand dunes with tree strips. Any break, no matter how small, is immediately repaired, since otherwise the force of the wind striking at the opening will soon ruin the entire strip. Wind damage has sometimes been so rapid as to require the rebuilding of the entire strip. In the Prairie States Forestry Project, the greatest emphasis is placed on the establishment of a dense border of low shrub species to prevent sun and wind from dissipating the litter, exposing the soil, and destroying the main stand itself.

FUNCTIONS OF FORESTER AND ENGINEER

Unfortunately, these simple principles of ecology, and indeed of other natural sciences, have generally been forgotten or neglected in the planning, design and construction of roadways. For this neglect, foresters must take the blame. If engineers, in their normal zeal to build roads at the least possible cost and with the greatest speed, plan locations and resort to methods of construction inimical to the long-run interests of watershed protection, the fault lies less with them than with the forester. The engineer with his limited knowledge of geology and ecology cannot perhaps be expected to consider these factors adequately. It may indeed be claimed that the likely effects of road construction on cover and its soil and water relations are matters far beyond the scope of the engineer's knowledge and responsibility. If so, his authority must be curtailed accordingly.

The forester, however, is very much concerned with all these matters. His is the task of maintaining watershed stability. Every significant break in the vegetation weakens that stability and the value of the cover for waterflow regulation and flood hazard reduction. Upon him, therefore, and not the engineer rests the primary liability if unsatisfactory watershed conditions lead to heightened flood waters and destructive sedimentation. His authority must be increased accordingly.

The forester, then, must be enabled to exercise the same degree of leadership in respect to road construction as he does in

cover management. In this he can benefit by utilizing the knowledge of competent geologists and ecologists.

By ground inspection of proposed road locations, it should first be determined whether construction may safely be undertaken at all. Such warning signs as the occurrence of badly faulted or shattered rock, land slips, heavy clay soil, unusual drainage conditions or other evidences of slope instability are important factors to consider; likewise, the occurrence of old growth timber or other natural plant associations slowly developed under severe environmental conditions and high susceptibility to sudden exposure. Such inspection may in many instances lead to a decision to re-route a given road entirely or else not extend it above certain elevations, or through certain rock formations or in special types of cover.*

Nor should determinaton of drainage facilities, or of grades, widths, and gradients of cut and fill slopes be left wholly to the engineer. Roads too often are located without due regard to drainage. Many needless steep grades, culverts and bridges are constructed. These favour accelerated erosion and run-off. Concentrated drainage water is often released on steep slopes without protective measures to prevent resultant gullying.

Road construction, even under proper design, and in areas of fairly stable condition, may produce serious results. The heavy use of dynamite in blasting mountainsides is a highly questionable practice. In some rock formations dynamiting sets up series of short waves which tend to cause slides and debris movement both in the near vicinity and on distant slopes. The practice of dumping debris on slopes and in water courses, and the failure to stabilize road banks promptly while construction is in process, are other sources of preventable damage.

Emphasis should be placed on the minimum opening up of cover, on the fewest possible cuts, and on the smallest possible extent of overcoast slopes. Road cuts might be narrowed or eliminated in certain critical localities by building up the foundation through fills.

* See John B. Bertram: The Gros Ventre landslide and flood. The "Midwest Review," 1927, as an excellent illustration of the type of analysis that should precede road construction in areas of geologic instability. This article was republished in the Wyoming "State Tribune," Sept. 25, 1940.

In some situations one-way loop roads would provide as effective service, at equal cost, as the standard two-way width.*

On federal lands, the control of forest development roads such as truck trails, recreation and administrative roads, is already in the hands of the administrative agencies concerned. Pressure from special interests surely is no excuse for permitting the building of roads where proper examination indicates the net effects to be detrimental. Proposals to widen existing old roads now in stable condition should especially be scanned. The widening of such roads has not only resulted in destroying the stability of the road banks, but has often created new and far worse problems than before. Where state or other highways are projected into headwater areas, foresters should have the right to pass on the plans in reference to land and cover conditions. Where such highways now exist or are under construction, foresters should be insistent on applying every safeguard needed to minimize disturbance of the natural site.

The plea of "multiple-use" in support of proposals for promiscuous road building should deceive nobody. A compromise between two values achieved by the serious impairing of one value is surrender and not compromise. It is indeed for the very purpose of retaining, and not sacrificing, the multiple-use concept that foresters should take pains to scrutinize every proposed construction project in headwater areas. If the evidence, based on thorough and competent field examination is that construction, no matter how carefully planned and controlled, is likely to have adverse results, it is clearly not in the public interest and should vigorously be protested. If we foresters would protect the forest, if we would protect especially its very protective function, we must cope with this new menace, this widening man-made pestilence—the headwater highway. Only by such a positive and conscientious approach to the problem of watershed management can we foresters, as custodians of the Nation's watershed resources, render our full public service.

---

* Such guide-books as the "Truck Trail Handbook" (Forest Service, 1940) and the "Manual for Soil Erosion Control in the Tennessee Valley" (Forestry Relations Dept., T.V.A., 1939) represent excellent treatments of the remedial phases of road construction. It is hoped that handbooks emphasizing the preventive phases from the standpoint of geology and ecology will soon find their way into the forestry literature.

LITERATURE CITED

1. ANONYMOUS. 1940. Influences of vegetation and watershed treatments on run-off, silting and streamflow, a progress report of research. U. S. Dept. Agric. Misc. Publ. 397.

2. FRANK, BERNARD. 1939. Farewell to the Smokies. Nature Magazine 32: 99-104.

3. KRAEBEL, CHARLES J. 1936. Erosion control on mountain roads. U. S. Dept. Agric. Circ. 380.

4. LORD, RUSSEL. 1940. Forest outings. Forest Service, U. S. Dept. Agric. (page 246.)

5. LOWDERMILK, W. C. 1937. Land use patterns in erosion and flood control. Jour. Forestry 35: 1040-1055.

6. MEADOWCROFT, NEIL F. AND E. C. MARLIAVE. 1935. Erosion survey San Francisco peninsula reservoir silting. Forest Service. Unpublished mss.—*Journal of Forestry*, Vol. 39, No. 3, dated March, 1941.

FORESTRY IN BALUCHISTAN

Those who have visited Baluchistan, even if such a visit was confined to Quetta only, will know that most of the country, the total area of which is 126,000 square miles, of which 53,000 square miles are under British administration, is mountainous, with broad upland valleys, and that there is a striking lack of trees and a general absence of vegetation. Barren, sunburnt, rugged hills scored by rocky, precipitous gorges, the slopes with scattered dots representing stunted juniper or olive trees alternating with bare stony plains. Parts of this country, as is the case with the adjacent Seistan and Iran, are fertile enough once water can be brought to them. The rainfall is low, 5—15 in. (the latter in the highlands), but is not so deficient that it could not support, and did once support a better type of vegetation. Examples are noted of forests having disappeared during the last 50 years, notably around Quetta and near the railway, around Fort Sandeman and Loralai, near Tomagh State Forest, and so forth. It is held that the desert conditions are advancing from the west and that these conditions are due

to the improvident and unchecked habits and actions of the population—felling, lopping, bark stripping and excessive and continuous goat browsing, in which the nomads are probably the worst offenders. Erosion is very severe, and one stream which has been under observation is reported as carrying away as much as 450 tons of soil in an hour. Many of these facts have been known for the last three or four decades, but they have never received really serious attention by the administration, and such forest service as there has been, has been negligible and of inferior status.

Attention has been directed to the present position of affairs in a "Note on a Tour of Inspection of Baluchistan" by Mr. S. H. Howard, acting Inspector-General of Forests (Government of India Press, Simla, 1940), and the report comes none too soon if the remnants of vegetation and the forests in the highlands are to be saved from extermination.

It is a curious reflection on British administration that in so many parts of the world at the present day the similar problem of the man-made desert being brought about by the unchecked acts of the people upsetting to the ordinary laws of Nature is presenting itself to the British administrator.

Juniper (*Juniperus macropoda*, Boiss.) is one of the chief species of the country, and there are remnants of an old forest at Ziarat. The wood of this tree could, says Mr. Howard, be used for pencils, slate frames, picture frames, and so forth, for which a sale might be developed, or a local factory might pay. This presupposes that a greater protection of the forests is introduced by Government and that the Government forest area should be raised from 0.6 per cent. of the country (its present extent) to something nearer 20 per cent. Other tree species are olive (*Olea ferruginea*) and khanjak (*Pistacia Khinjuk*). Of these, rough statistics appear to show that a juniper takes 40—180 years to grow one foot in girth (a 6-foot tree is 250—1,000 years old), an olive coppice shoot about 35 years to grow one foot girth and a khanjak about 25 years. The principal minor product is *Ephedra*, but *Artemisia, Hyoscyamus*, Datura juniper berries and perhaps Pyrethrum are other possibilities. In the highlands one of the chief species is the beautiful chilghoza or silver-barked pine (*Pinus Gerardiana*).

Of course, in so dry a country fuel becomes an important problem. There appears to have been a great development in its supply during the last few years with a corresponding high level of expedition in extraction. This scheme would be disquieting in so barren a country, and Mr. Howard makes recommendations which would certainly appear to be required, that a chief forest officer from the Imperial Forest Service should be appointed, and that the forestry question in Baluchistan should be treated as a question which has become of serious importance if the conditions of life of the population are to be improved instead of the country being permitted to fall into a state of greater desiccation and denudation.—*Nature*, Vol. 147, No. 3725, dated March 22, 1941.

THE IMPORTANCE OF FOREST PRODUCTS IN NATIONAL DEFENSE

By Carlile P. Winslow

National defense means more than a big army, a two-ocean navy, a skyfull of airplanes—it means an adequate supply of natural resources, of which timber and forest products are outstandingly important.

A nation that has within its boundaries a bountiful supply of forest products has an enormous advantage. Fortunately, the timber supplies of the United States, except for certain special purposes requiring relatively minor quantities, seem ample to meet our forest products needs of the present emergency, and doubtless for future emergencies if we will carry out sound forest practices with our abundant forest lands.

The combatants in the present European war are using a veritable host of diversified forest products, some of which are age-old whereas others are the products of modern research. They include such things as wood for cantonments, barracks, hangars, boats, wharves, bridges, pontoons, railway ties, telephone poles, mine props, and shipping containers; plywood for airplanes, air-raid shutters, prefabricated housing, assault boats, ship interiors, truck bodies, and army lockers; fuel for airplane engines, gasogenes, and

trucks; pulp and paper for surgical dressings, boxes, cartridge wrappers, and propaganda distribution; synthetic wood fibers, such as in rayon, artificial wool and cotton, for clothing, parachutes* and other textiles; wood cellulose for explosives; wood charcoal for gas-masks and steel production; † rosin for shrapnel turpentine for flame throwers; cellulose acetate for photographic film, shatter-proof glass, and molded articles; wood flour for dynamite; wood bark for tannin and dyestuffs; and rubber for tires, tanktreads‡ and other military uses.

In the last war the United States had 20,000 Americans scattered throughout France operating sawmills and cutting forests for bridges, railways, and other war uses. As high as 30,000 trees were used daily by a single French army corps. Simultaneously the Forest Products Laboratory§ was expanded six-fold and operated 24 hours a day keeping abreast of the various technical wood problems of the Army, Navy and other defence organizations.

Discoveries in new and wider uses of wood have gone so far to-day that it is essential to our national defense to keep abreast of them. The Germans, in their four-year plan under General Goering, classed forest products as the second most important natural resource of the country and strenuous efforts were made to use every scrap of wood to aid the military and defense situation. Because of the shortage of food in Germany and also because of the high cost of crude oil and gasoline, attention was given to the production of sugar and alcohol from wood. Raw wood sugar can be used for animal food, and with refinement for humans. It may be fermented with yeast to form ethyl, or "grain" alcohol to replace gasoline. A shortage of wool and the fact that there is no domestic cotton, directed the Germans to the production of "wood-wool" and "wood cotton." A certain percentage of wood-wool is required in all German uniforms. Research work in Europe has also brought steady progress in developing a wood-gas generator, so that for the past several years buses, trucks, and even pleasure cars have been powered by this means.

---

* Textile World, p. 87, Sept., 1940.

†Wood, p. 209, Sept., 1940.

‡ Fortune, p. 61, Sept., 1940.

§ Maintained at Madison, Wisconsin, in co-operation with the University of Wisconsin.

Fundamentally there is nothing substantially new in these technical developments that the United States is not familiar with but at that time and even now they are not economically practical in the United States. However, should unforeseen disaster befall us the techniques for producing such things are well known and wood could be used over here for such purposes.

With this sketchy perspective as a background, and recognizing that technological advances with wood and other products have brought about many changes in our present forest products war needs from those of the last war, there are nevertheless great numbers of diversified uses requiring forest products and many technical problems for their improvement confronting us to-day. I will describe a few of the more important, either from the standpoint of quantity or of technical problems inherent to their use.

LUMBER AND STRUCTURAL MATERIAL

If we consider national defense in terms of an American army of 1½ million men by July, 1941,* we think at once of cantonments and training centres; and these mean not only barracks but recreation halls, theatres, hospitals, mess halls, warehouses, post exchanges, and other buildings—all of which require enormous quantities of forest products.

Thus, a score of modern towns to house our soldiers are being erected at various strategic points throughout the United States. With few exceptions, the structures are being built of wood, this material lending itself to greatest speed in procurement and labour supply. The buildings are well planned for the health and comfort of the men and are superior to the cantonment construction of World War days. The structures are adapted to three temperature zones.† Some in the deep South consist of framed tents but the majority located elsewhere are of standard wood frame-and-sheathing construction.

An idea of the magnitude of this undertaking may be had from the fact that the buildings to be occupied by a division of

* Eng. News Rec., p. 28, Oct. 1940.
† Eng. News Record, p. 43, Oct. 1940.

approximately 17,000 men* cover 1 square mile. It is estimated by the National Lumber Manufacturers Association that 1,500 feet of lumber are required for each enlisted man housed in barracks and 825 feet of lumber for each man housed in a tent camp. The whole program will use about $4\frac{1}{2}$ billion feet of lumber. This includes $1\frac{1}{2}$ billion feet for industry housing, 1 billion feet for crating, and $\frac{1}{2}$ billion feet for the Navy.†

Efficient defense means efficient workmen behind the lines as well as at the front. Efficient workmen, in turn, mean living quarters that meet modern American standards. The War Department‡ estimates that at least 7 men are needed in war industries for every soldier on the firing line. To house the workmen needed at our shipyards alone will, according to the National Defense Advisory Commission, require 42,000 new housing units; the Navy needs about 65,000 houses. The foregoing figures do not include housing for workers in Army and Navy armament factories yet to be built. The houses are to be erected by private builders, using public funds.§ It is reassuring to know that officials are disposed to use lumber so far as is possible for this construction.

Wood is particularly well-suited to hangars in wartime due to the speed of erection and mainly with unskilled labour, thus releasing the skilled artisans for other important war-time production duties. One of the largest hangars for the R.A.F. in Great Britain is reported to have just been completed, having been constructed of timber. The area of the roof of this hangar is more than 70,000 square feet.||

Since the very life of the British navy and of her manufacturing interests depends upon the uninterrupted operation on a vast scale of the English coal mines, one of the most urgent demands of the United Kingdom at the present time is reported in the official Canada Year Book to be for mine props. Normal imports amount to more than 100 million cubic feet of wood for this purpose.

---

* Amer. Lbrmn., p. 40, Oct. 5, 1940.

† Maj. M. E. Barker, U. S. Chem. Warfare Service, p. 463, Chem. & Met. Eng. July, 1940.

‡ Teesdale, L. V., Notes on Cantonment Plans.

§ Charles F. Palmer, Co-ordinator, N.D.A.C., p. 29. Amer. Lbrmn., Sept. 21, 1940.

|| Australian Timber Journal, p. 378, June-July, 1940.

About 70 per cent. of this formerly came from the Baltic countries, and steps are now being taken to secure large quantities in Canada and Newfoundland.*

Should the United States be required to fulfill her Western Hemisphere defense pledges every kind and type of sea-worthy ship that can be built will be in demand; many will be of combined wood and steel. Even ships now built of steel require miles of planking for docking. From Australia comes the report† that some battleships require about 500,000 board feet of lumber and certain ocean transports take about 700,000 board feet of lumber and about 300,000 square feet of plywood. Then there are the mine-sweeping vessels, high-speed sub-chasers, and motor assault boats of the mosquito fleet, all of which consume large quantities of wood. A large floating target, such as used for training naval aerial bombers, takes about 200,000 board feet of timber.†

Approximately 90 per cent. of the wharves and docks of the world are constructed of timber. The British are reported to require 3,600,000 board feet of timber for dock and harbour maintenance alone.†

Important to shipyard engineers, military bridge builders, and all others engaged in heavy wood construction are the modern metal connectors recently devised for beam joints. Such connectors make it possible to increase the strength of heavy wooden structures by manifold.

AIR-RAID PRECAUTIONS

In the event of United States entry in the war the recent research in impregnating wood with fire-retardant chemicals will, no doubt, come into use for protecting Navy yards, hangars, and other wooden shelters from incendiary bombs. A combination shutter of sheet steel over plywood is reported as being used in England for bomb splinter protection of windows in city factories and buildings.† Timber and sand are used on the top floor of buildings as protction against bombs of the thermite variety. A new

* Canada Year Book 1940.

† J. M. Gosper, Director, Timber Development Assn. of Australia, Australian Timber Journal, p. 355, June-July, 1940.

type of paint containing borax, developed by the Forest Products Laboratory for prevention of the spread of flame on timber, has already been put to use by the Canadians. After an air-raid, timber is, of course, required for bracing walls of buildings that have been hit and if left would create a public hazard. A special concession has now been made in England to occupants and owners of houses whose premises have been damaged in air-raids, whereby they can obtain timber up to the value of $25 on declaring that such timber will only be used to repair such damage.*

CONTAINERS

Boxes and crates of all kinds absorb great quantities of wood. Already in Great Britain, for example, 3,500,000 boxes for small arms ammunition, 1 million cordite boxes, 10 million boxes for canned food, and 1 million cases of bacon are reported to have been ordered. Cases are also required for instruments such as range finders, sextants, and the like. Crates for airplanes and airplane engines utilize great quantities of timber.

During war cargoe space is at a premium. It is essential that as little room as possible be taken up by the containers, and yet they must be strong enough to protect their contents against rough handling—particularly munition shipments. The Forest Products Laboratory has recently been called on to redesign a wooden container for the shipment of bombs. The redesigned container employs aspen instead of the more expensive white pine, requires less cargo space, less lumber, less weight, yet has greater strength than the original container.

PULP AND PAPER AND OTHER CHEMICAL PRODUCTS

Before the current war in Europe 30 per cent. of our wood pulp and 78 per cent. of our newsprint were imported. In this era of world-wide struggle for raw materials it is of great importance to our national defense that research to increase species utilization and develop high yield processes has advanced to a point where to-day the United States has the species to supply its own pulp and paper needs. Moreover, wood, in the form of pulp, may prove an

* Wood, p. 237, Oct. 1940.

important element in further improving our trade relations with South America.

Of particular significance to the international pulp situation is the fact that research has produced a high-yield semi-chemical pulping process that permits the use of wood, hardwood species, as an important component in newsprint paper which at present uses the more valuable softwood species exclusively. The process is also applicable to low-cost container boards and by a new laboratory technique to an exceptionally high yield and high quality alpha-cellulose which has possibilities of direct nitration into explosives.

It is extremely difficult in our defense planning to estimate well in advance our military needs for chemical commodities. In the event of need, however, alcohol, acetone, acetic acid, mannitol, sorbitol, glucose, and various other essential war chemicals can be produced from wood.

WOOD IN AIRCRAFT

Foremost on the United States national defense program are airplanes—maybe fifty thousand of them by the spring of 1944.*

Although there has been a shift to metal aircraft in recent years, the present war emergency is again bringing a demand for wood. Outstanding needs seem to be for spruce, for wing spars, and plywood for the covering of fuselages and wings in training planes; also for a sheet material adapted to molding or pressing-to-form which would enable all, or parts, of fuselages of wings to be molded in mass production operations; and for an improved laminated, compressed, wooden propeller of light weight to meet the requirements of increased engine horsepower.

At present wood is widely used and will probably continue to be used for wing spars and ribs to support fabric covering in civilian trainers and in light inexpensive private planes. In addition, wood spars and other framing members with plywood covering are now being applied in wings and fuselage of military trainers and in the wings of some of the faster and more expensive private planes. Indications are that this use will increase.

A recent survey by the Forest Products Laboratory disclosed widespread interest on the part of the Army, Navy, and aircraft

* Mech. Eng., p. 683, Sept. 1940.

manufacturers, in methods of molding plywood under fluid pressure into skins of acceptable weight that will be secure against the wrinkling and buckling to which metals are subject. Such skins, which can be varied from one part of the surface to another in accordance with strength requirements, will form a shell that has high efficiency both aerodynamically and structurally and will require only light framing members to support it. Although this molding process is still in the experimental stage, rapid development is expected. This type of construction will lessen the need for wood of the near perfect character required for spars. It should make possible the utilization of veneers of many species not now considered for airplane use and should broaden the base for raw material supply as well as make supplies of wood available in every forest region.

A new synthetic resin treatment of wood developed at the Forest Products Laboratory offers important possibilities for such exacting uses as airplane wings, fuselages, and other surface parts. The treatment consists of impregnating and plasticizing the cell wall structure of veneer with synthetic resin-forming chemicals from which can be made, at low pressures, a highly compressed laminated wood with high mechanical properties, moldable to double curvature, and with an extremely smooth surface, and a high resistance to swelling and shrinking.

This synthetic resin treatment may also prove especially applicable to propeller construction. It offers the possibility with low pressures and in one pressing operation of controlling the density as desired from hub to tip and gives practically a moisture-proof nonshrink product. German and English propellers are being constructed with most of the blade of laminated, light-weight, uncompressed wood, and the hub section of compressed, laminated wood bonded with phenolic-resin glue.

NATIONAL DEFENSE NEEDS FOR FURTHER RESEARCH

Five years ago, in July 1935, Wheeler McMillen, president of the National Farm Chemurgic Council, defined the role of research in national defense in the following words: *

* Agricultural Engineering (Vol. 21, No. 7), July 1940.

"From the standpoint of national defense, the clear objective of research should be to make provision for the production, at some cost, from some domestic source, of every item that it is anticipated may ever be required for the use of our defensive forces; and, further, of every item of domestic need that might be shut off by the incident of foreign wars in which this country may not be engaged.

"Department of Agriculture research projects which clearly contribute to these ends should, therefore, be worthy of consideration by the Congress."

Past experience has clearly demonstrated that technologic and research work are critically essential to the efficient use and adaptation of wood for defense purposes on both the combat and economic fronts.

Important problems confronting the maximum efficiency of aircraft production which relate to the present and possible future use of wood, plywood, and other forest products are the development of fuselages, wings, and other parts, in whole or in part, by mass production molding or pressing; development of an improved, high-strength, light-weight propeller of variable density from laminated, compregnated wood for the high-powered motors that are increasingly in demand: satisfactory bonding of plywood to wing ribs or other elements of training planes by means of cold-setting resin glues; assurance of an adequate supply of spruce lumber for aircraft wing spars; determination of the basic properties of plywood as an engineering material; development of proper fastenings for wooden structural members of aircraft; development of a glueable water-resistant coating for interior surfaces of wood wings or hollow wing spars; development of paints and varnish finishes that will impart a smooth and durable surface to the exposed wooden parts of airplanes; determination of the characteristics of wood construction, including acceptable repair methods for various types of structure, bolt spacings, and stress concentrations; and the development and testings of various glues and gluing techniques.

Other defense problems which either are or may become critical as the Nation's defense effort gathers momentum include the faster drying of walnut gun-stock blanks and other items for special requirements; finding a suitable substitute for East Indian teak

for battleship decking and for gun-mount bases; developing an improved plywood, such as compreg., for planking and decking for assault boats, sub-chasers and similar craft; increasing the supply of pontoon timbers and planking through the development of chemical seasoning methods and the broadening of the specifications for this stock; providing adequate protection against decay for wood boat frames and other parts; the further improvement of wood gas-mask charcoal; special paints, coatings, and other fire-retardants for hangars and other critical structures; improvement of designs and specifications for shipping containers of all kinds for specific military commodities; the possible development of an effective anti-knock chemical for aviation gasoline from hydrogenated lignin products and the production of other essential wood chemicals; a good domestic substitute for cork and kapok is needed; and finally wood process specifications for many articles and structures need to be critically examined, revised, and geared to the present emergency condition of stocks, supplies, and special needs.

In national defense housing there is an increasing need for engineering data on the strength and design of both permanent and emergency wood structures, especially on modern connectors and other joints and fastenings, glued-up laminated structural members, and prefabrication of houses for speedy erection at the site, also on seasoning, grading, and selection of lumber for rapid construction; moisture control in barracks and houses to prevent condensation; and protection against decay, weathering, and fire.

On the economic front, the use of our forest resources to strengthen relations with Central and South America looms large. About 45 per cent. of the land area of tropical America, or approximately four times the forest area of the United States, is forest land. Hardwoods are in the great majority. Although tropical American timbers, such as mahogany, Spanish cedar, and dyewoods, have been important articles of trade for several hundred years, only a few of the many woods have found a place in the markets of the United States or the rest of the world. Some of the South and Central American cabinet woods are not grown in the United States at all. It would appear, therefore, that steps should be taken to increase our imports of hardwoods from these countries, but before that can

be done research is needed to determine (1) for what uses the importation of tropic woods will be most urgently needed in the near future, and (2) which of the accessible tropical species possess properties that will best fulfill the uses to which they will be put.

The possibility of developing a large pulp and paper market in Central and South America and the possibility of having to meet our own needs with our own forest resources both suggest the need of further broadening the species base of our paper industry to fullest extent, as well as enlarging the number of kinds of paper made from our own woods.

Possibilities of expanding the plywood industry within our own country and of increasing our export business with Central and South America are great. But in order to do so the raw material base of the industry must be broadened. Methods of treating various woods prior to cutting them into veneer and improved veneer cutting and plywood manufacturing methods must be developed and grades and yields determined for species of wood other than Douglas fir and for logs of lower quality than are now used. This would include woods in the southern states where structural plywood is not now manufactured in any quantity and where a labour outlet, which a broadened plywood industry would supply, is badly needed.

Here in the United States, every individual, every organization, and every resource is expected to contribute the utmost toward the national defense of our country. The individuals are willing, the organizations already exist, and the resources, including forests among those of major importance, are bountiful. This combination, aided by research, can build a strong and secure national defense on both the combat and economic fronts. All that is required is the "green light."—*Journal of Forestry,* Vol. 39, No. 2, dated February, 1941.

ROSHA GRASS OIL

By Prof. Jai Chand Luthra
(Punjab Agricultural College, Lyallpur.)

A number of oil-yielding grasses are found in India. The more important of these are:

1. *Cymbopogon martini* Watson (Motia and Sofia varieties).
2. *C. nardus* Rendle (Citronella oil).
3. *C. citratus* Stapf (Lemon grass).
4. *C. flexuosus* (Nees) Watson.
5. *C. schocnanthus* Spreng (Camel grass oil).
6. *Vetiveria zizanioides* Nash (Khaskhas).

C. martini Watson is widely distributed in India and its use as a fragrant oil appears to date back to an early period. The refined product is technically known in the trade as Palmarosa oil.

India has been exporting Palmarosa oil for many years to Europe and America and has had almost a monopoly of it. Palmarosa oil is used as a base for the manufacture of perfumes on account of its principal constituent geraniol of which it contains about 90—95 per cent. It is also used for scenting toilet soaps. The demand for Indian palmarosa oil has declined a good deal on account of other countries, e.g., Java, having taken up the cultivation of Citronella grass as a source of geraniol. The rosha grass oil is, however, of superior quality and fetches a higher price. But in spite of this advantage, India appears to be losing its overseas market. The position, therefore, requires attention. In some parts of India the manufacture of perfumes has been started and palmarosa oil has begun to be used for that purpose. With the availability of this oil there is obviously a great scope for such industry here.

To establish the industry on a firm basis it is necessary to cultivate the grass, because not only will the yield be increased by cultivation but also the selection of the variety *motia* will ensure supplies of the best type of geraniol. The late Prof. Puran Singh, Chief Chemist, Forest Research Institute at Dehra Dun, realised that there was a future for this industry. He obtained 400 acres of land on lease and laid out a plantation near Lyallpur in 1924. He succeeded in establishing the grass over an area of 230 acres. He put up

a steam distillation plant and 3,000 to 3,500 pounds of palmarosa oil were produced annually. This was the first example of cultivation of an essential oil grass in India. The Punjab, however, does not provide the best conditions for growing it. It is subject to severe frost which kills the grass and reduces its oil content. The grass is grown under canal irrigation and the cost of cultivation is also high on account of water and revenue charges. There are localities in other provinces more suitable than the Punjab and as it offers a great scope for a flourishing indigenous industry, experiments should be conducted for cultivating it. Places with an ample rainfall would be most suitable, as the cost will be considerably reduced.

Rosha grass is a perennial plant. It attains a height of about 6—8 feet. The aerial parts die in winter. Being very susceptible to frost, its leaves and shoots may dry up even in November when there is early frost, but usually withering starts in December, and by the end of January, the plant dries up completely. The dead stumps of the plants are burnt to make room for new shoots. The rootstocks sprout in the spring and, by the midde of October, the grass is in blossom and cut for distillation.

The flowers contain a higher percentage of oil (1.4 per cent.) than other parts. The leaves also contain about 1.4 per cent. oil while in the stalks the percentage is as low as 0.03. An acre of the grass yields 15—20 lbs. of oil. Frost causes a loss which may amount to ·54 per cent.

Full analysis of a sample of palmarosa oil supplied to me by Dr. S. Krishna, D.Sc., Bio-Chemist, Forest Research Institute, Dehra Dun, U. P., is as follows:

Colour and odour—Light yellow, pleasant odour.

Specific Gravity at 20°C.	...	0.8822.
Refractive index	...	1.4663.
Angle of rotation	...	+0.21.
Solubility in 70% alcohol, parts	...	2.2.
Acid value	...	1.74.
Ester value	...	14.93.
Ester value after acetylation	...	276.27.

Corresponding to:

		Per cent.
Total geraniol	..	95.83.
Free geraniol	...	91.68.

Higher acid value indicates that some de-esterification has taken place, which is confirmed by the rise in free geraniol.

Botanical studies of the plantation have furnished important results regarding the type composition of the crop. As noted above, the typical plant possessing essential oil of the standard quality and purity is the *motia* variety of *Cymbopogon martini* Stapf. It has, however, been noticed that the grass raised from seed obtained from forests is a mixture of several forms. Eleven types differing in morphological characters have been distinguished. All these types are perennial and have almost the same period of growth as the *motia* variety.

Type No. 1—Stalk, medium thick; height, over 6 feet; leaves 6—10 inches long and green; internodes, 4—6 inches long; inflorescence, dense; spikelets, on slender long stalks. Flowers in early October.

This type is rich in palmarosa oil and gives the best yield. It is the typical *motia* variety.

Type No. 2—Stalks, medium thick; height over 5 feet; leaves thin, pale-green and 6—8 inches long; internodes, 3—4 inches long, it is one of the early flowering types and has a long and lax inflorescence. Flowering starts in early October. Next to No. 1 in oil content.

Type No. 3—Stalk slightly thicker than Types Nos. 1 and 2; height, about 6 feet; leaves 10—12 inches long, dark-green; internodes are 6—8 inches long. The inflorescence is borne on long, slender stalks; spikelets very lax. The inflorescence arises out of the axils of the upper leaves which decrease in size gradually towards the top.

Flowering starts early in October.

Type No. 4—Stalk, coarse and thick; height, over $6\frac{1}{2}$ feet; leaves 10—12 inches long, very thick, dark-green, with pointed, sharp ends; internodes short and thick, 3—4 inches long. The inflorescence is borne on stout, short stalks and is thick. It is a late flowering variety, and flowers in November.

Type No. 5—A very conspicuous type with bluish red foliage; stalks medium thick; height about $5\frac{1}{2}$ feet. The leaves are 6—9 inches long, with closely clasping sheaths covering whole of the

internodes, which are 4—6 inches long. It flowers late in December and bears very scanty flowers in lax, thin inflorescences; oil content, poor.

Type No. 6—Stalk, thick and coarse; height, over 6 feet; leaves thin, 8—10 inches long; internodes are 6—8 inches long. Inflorescence is very lax on long, very thin stalks. Flowers in early November.

Type No. 7—Stalk, medium thick; height about 5 feet; very leafy; leaves dark-green, ½—¾ inch broad and 8—10 inches long. Leaf-sheaths are long and clasping; internodes 4—6 inches long; flowering scanty, inflorescence is short and spikelets lax. Flowers in early October.

Type No. 8—Stalk, thin, dwarf, bushy type; height 3½ feet only; leaves 4—6 inches long, light green, turning brown at maturity and are borne on closely sheathed internodes; 2—3 inches long. Inflorescence is very short and thin; glumes have reddish colour. Flowers in early November.

Type No. 9—Another thin-stalked, dwarf type, 3¾ feet high; leaves short and pale-green, 4—6 inches long, clasping the stalk rather loosely. The inflorescence is lax and scanty, borne on slender, long stalks. Flowering starts early, about the the middle of October, or even earlier.

Type No. 10—A thin-stalked dwarf type only about 3½ feet high; leaves, scanty, green, 4—6 inches long, on long sheaths; internodes 3—4 inches long. It has got a short, medium, dense inflorescence; flowers in October.

Type No. 11—A very conspicuous dwarf type not exceeding 4 feet in height. Stalk, thick and covered with short, thick, pale-green leaves, placed at right angles more or less to the main stalk. Leaves are 8—10 inches long and set closely together. Internodes are short, 2—3 inches long only. Very late flowering variety and is very poor in oil content. This is the Sofia variety.—*Current Science*, Vol. 10, No. 6, dated June, 1941.

INDIAN FORESTER

NOVEMBER, 1941

PHALARIS PARADOXA, LINN. F.

BY N. L. BOR.

This grass, which is a Mediterranean plant, was found in a collection of grasses from Baluchistan received in the F.R.I. for determination. As it is a new record for India, a description and plate are furnished.

On page 220 of the *Flora of British India*, Vol. VII, occur the words: "*Phalaris paradoxa* Linn. fil. is stated by Duthie, Grass. N W. Ind. to be Indian on the authority of Wallich (Nepal) and Stewart (The Punjab); but in Fodd. Grass. N. Ind. he says he has not seen specimens; nor have I. It is a Mediterranean plant."

A search in the library here for Walich's and Stewart's records having been of no avail, I enlisted the help of my friend, Mr. Narayanaswami, Botanical Survey of India, who is working in the Herbarium of the Royal Botanic Gardens, Calcutta. He informs me that these records are based upon sheets in the Calcutta herbarium and proceeds: "There is a sheet of Stewart's recorded from Lahore, but it is not *Phalaris paradoxa* Linn. f. It is simply *P. minor*. As regards Wallich's Nepal record, which Duthie has mentioned, Wallich's No. 3782A from Nepal, though named *P. paradoxa* L.f. and placed in a cover, is certainly not *P. paradoxa*. It is not *P. minor* Retz., because the barren narrow scale-like lemma below the fertile floret is absent in this specimen. I strongly suspect it to be *P. nepalensis* Trin. which Hooker reduced to *P. minor* in F.B.I. *P. paradoxa* Linn. f. is represented in this herbarium by a sheet of Griffith's, No. 159, from Afghanistan."

This grass is placed in *Phalaris* on account of its undoubted affinity with that genus. Those who are not specialists in the *Gramineæ* or who do not know the grass are likely to experience some difficulty in identifying the species, on account of the absence

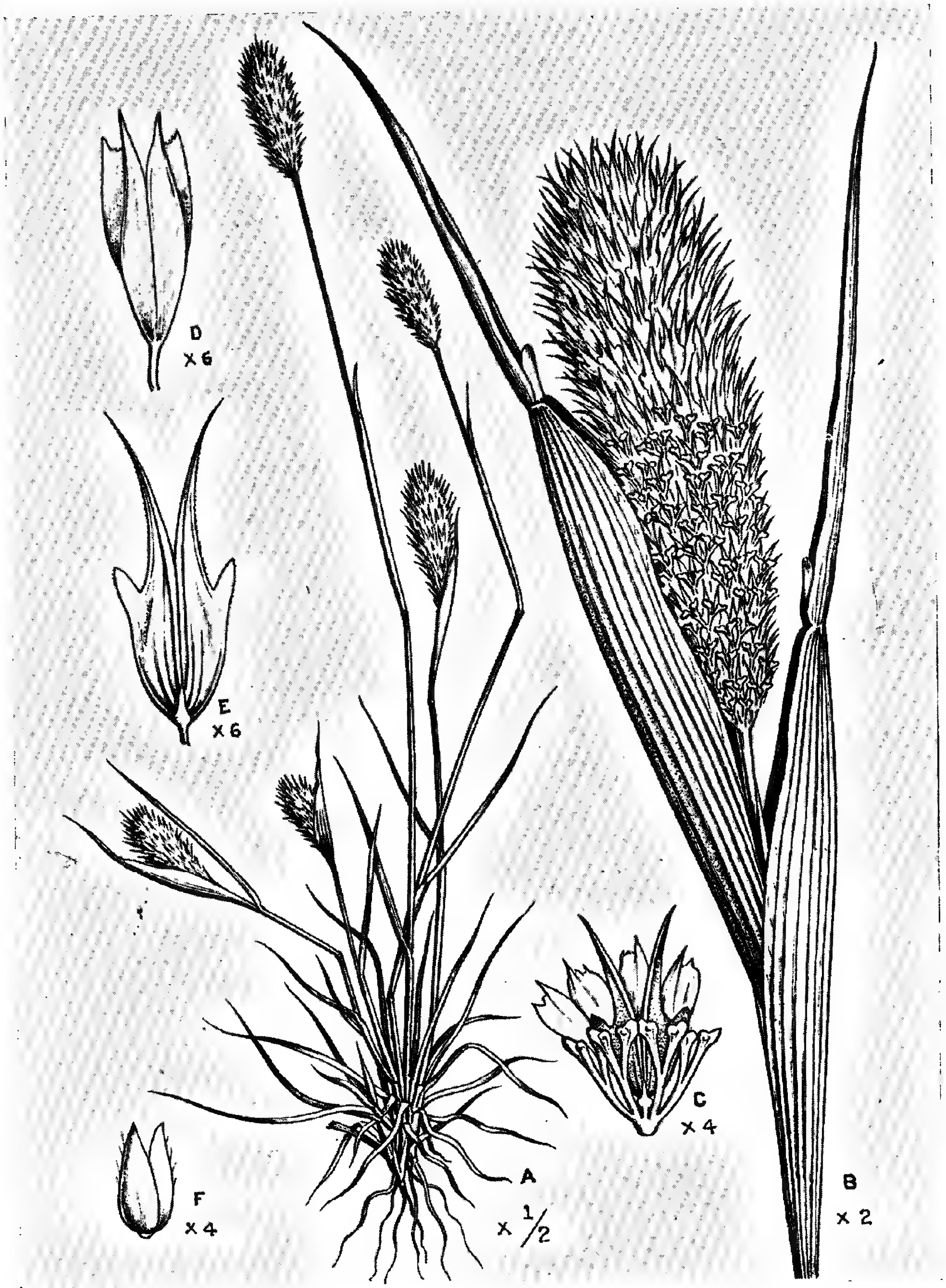
of florets below the hermaphrodite floret and by the presence of sterile spikelets of two kinds. With any of the ordinary keys it is impossible to get it even into its tribe, *Phalarideæ*, much less to its genus.

As the species is likely to occur in north-west India, a full description and plate are given.

PHALARIS PARADOXA Linn. f.

An annual grass with culms 30—60 cm. tall, which spread from the base but are finally vertical; culms glabrous, furrowed, minutely scaberulous; nodes glabrous. Blades of culm-leaves linear-lanceolate in shape, rounded at the base at their junction with the sheath, scabrous on both surfaces, minutely toothed on the margins, up to 20 cm. long by 5 mm. broad; leaves of the uppermost sheaths reduced, 2-3 cm. long by 1 mm. broad; culm-sheaths rather loose, smooth or scaberulous, glabrous; lower slipping from the culms and withering early; uppermost sheaths spathe-like, very broad in proportion to their length, hyaline on both margins, ending in a very reduced limb; ligule membranous, hyaline, erose at the top, up to 6 mm. long.

Inflorescence an ellipsoid panicle, 2—5 cm. long, half enveloped by the uppermost leaf sheath, of crowded spikelets collected in groups about a sinuous, unarticulated, pubescent, central axis which is shortly branched; branches very short and if further subdivided, the branchlets very short; branches and branchlets pubescent, ending in an articulation. On each articulation is seated a group of spikelets. Groups of spikelets of two kinds: (*a*) those of the upper part of the panicle and (*b*) those from the lower portion. Groups from the upper portion of the panicle consist of 6 or 7 long-pedicelled spikelets, the central spikelet being fertile, the outer sterile; pedicels all distinct from one another or sometimes 2 or 3 fused at their bases; the group as a whole deciduous from the pedicel on the central axis. Fertile spikelet hermaphrodite, 1-flowered; pedicel about 4 mm. long, terete, minutely scaberulous, expanded at the apex into a cushion for the reception of the glumes; glumes equal in length, 5—6 mm. long, slightly connate below, elliptic-acuminate when flattened, subulate-aristate, keeled, scaberulous on



Phalaris paradoxa Linn. f.

the sides and keel at the top, 5—7-nerved, the two outer side-nerves being close to the margin; keel with a prominent hyaline tooth-like wing; keel and marginal nerves bright-green in the upper half. Lemma 3 mm. long, smooth and glabrous except for a few hairs towards the summit, polished, ovate-acute when flattened, chartaceous in texture; palea, in shape, texture and appearance, similar to the lemma but smaller; stamens 3; anthers 1 mm. long; grain 2—2.5 mm. long. Sterile spikelets; pedicels terete, minutely scabrid, 3—6 mm. long, not expanded at the apex as in the case of the hermaphrodite spikelet; glumes equal in length, slightly connate at the base, rather narrower than those of the fertile spikelet and somewhat variable in length, 3—6 mm. long, usually acuminate at the apex or sometimes prolonged into a scabrid arista; nervation as in the fertile spikelet; outer nerves and keel coloured bright-green; lemma obsolete or entirely absent. In the lower portion of the panicle the spikelets are short pedicelled and while the hermaphrodite spikelet resembles those in the upper portion, the outer sterile spikelets are deformed and are represented by clavate-cuneate processes.

Distribution.—A Mediterranean grass extending to Mesopotamia and Afghanistan; collected at Quetta, 9-4-1941, by Harbhajan Singh.

Plate 16

Phalaris paradoxa Linn. f.

A. Plant, half natural size.

B. Inflorescence x 2 : the panicle is often half-buried in a sheath; the sterile modified spikelets at the base of the panicle are very obvious.

C. A bundle of sterile modified spikelets surrounding a fertile spikelet.

D. Sterile spikelet from the upper portion of the panicle.

E. Fertile spikelet from the centre of a bundle in the upper portion of the panicle.

F. Lemma and palea : there is no trace of the two lower florets usually found in the *Phalarideae*.

DEATH OF AN ELEPHANT BY LIGHTNING

BY G. EYRE HIGGINS,

Forest Manager, The Assam Railways and Trading Company, Margherita, Assam.

It may be of interest to those who are concerned with elephants, and perhaps even to those who are not directly in contact with them, to recount the curious circumstances surrounding the death of a tusker elephant through lightning-stroke.

Firstly, I might state that after fourteen years' experience of working with domestic elephants and also studying the habits of wild herds in the forests of Indo-China, Thailand, Burma and more recently Assam, I have never come across a similar occurrence. Lightning-stroke cases are but lightly touched on by such authorities as Evans, Sanderson, etc., and no specific case is actually quoted. I believe though there is such a case mentioned in the very excellent private Company records of Messrs. The Bombay Burma Trading Corporation Ltd.

The case which I am about to describe occurred in the Upper Dehing Forest Reserve, Lakhimpur, Assam, on the 3rd August, 1940.

The elephant in question, a tusker of about 35 years of age, belonging to Messrs. The Assam Railways and Trading Co., Ltd., was taken out from the camp by his *mahout* after work at about 1 p.m. to be let loose for grazing in the surrounding forest. The elephant was then in excellent health and had been so for months past. At about 5-30 P.M. on this afternoon there was a violent thunderstorm with very vivid lightning but practically no rain. This I was personally able to verify as I was passing along a road fairly close to the scene of the accident at the time when it must have taken place. The elephant was next seen by his *mahout* at about 6 A.M. when he went out to collect him on the morning of the 4th in the usual way. The elephant was found dead in a very curious and amazing attitude. He was then still in a semi-upright position with the front legs bent and the back ones straight and fairly wide apart, head pointing to the ground and the tusks buried

for a few inches in the earth. In fact, he was in the kneeling position which tuskers usually adopt when getting well down to insert their tusks under a heavy log for rolling. I myself cannot claim to be a witness of this curious fact as, by the time report had reached me and I had arrived at the spot much later in the day, decomposition and consequent swelling of the carcase had set in and, throwing it off balance, it had rolled over on its left side. However, there were several reliable witnesses of this fact and the evidence I found tended to substantiate their statement.

On receiving the report that the tusker had been killed by lightning I was decidedly sceptical about this being the cause of death, the incident being so unusual; and I arrived on the scene in that frame of mind. However, I was able to dispel all such doubts very shortly.

On arrival I found the carcase of the tusker lying on its left side close up to the foot of a very large *Dipterocarpus macrocarpus*, which had a girth of 13 feet at breast height. In fact the tusks had left marks in the ground right up against the base of the tree, made when the elephant must have died in the position as described above. On glancing up the tree, a very tall one of about 120 to 130 feet in height, I noticed that the crown was badly shattered and splintered by what can only have been lightning. One very large branch had fallen close to the carcase and at first I thought this might have caused the death of the elephant, but the marks in the soft earth disproved this; the branch lay just where it had fallen. Further investigation disclosed large and small pieces of bark and timber, which had been badly charred, lying scattered in all directions, some at very considerable distances from the base of the tree.

On examining the carcase, little signs of violence were noticeable. In fact the only ones worthy of note were a markedly shrivelled appearance of the skin covering the upper maxilla on the right side of the head, and the state of the right eyeball, which had taken on a white opaqueness, not unlike an advanced form of cataract.

Whether the elephant had his trunk or head actually in direct contact with it at the time the tree was struck, must, of course, be a matter for speculation, but taking the evidence as it stands it is

a very fair assumption, and I personally believe that it must have been the case.

There cannot be any doubt but that this was a genuine case of lightning-stroke. The tusker must have been killed by shock causing instant death through paralysis of the nervous system, for the actual burns were too superficial to cause death by themselves.

The accident took place in heavily-timbered evergreen forest, but the crown of the actual tree which was struck was well above the surrounding canopy.

SILT-BEARING STREAMS

By G. C. Cheyne,

River Training Expert.

The following is a short description of the hill streams which discharge into the Myitmaka and the methods which have been adopted to stabilize their channels.

The Prome and Tharrawaddy forests lie on the western slopes of the Pegu Yomas, and are drained by the feeders of the Rangoon River, which is known as the Myitmaka River at its headwaters and lower down as the Hlaing River.

All these Yoma torrents, viz., Shwele, Taungnyo, Bawbin, Myole, Gamon, Minhla, Mokka, Bilin and Thonze streams, due to their reception basins being highly susceptible to the erosive powers of the rainfall, carry enormous quantities of silt and rubbish of all sorts during floods. They flow approximately from north-east to south-west across an alluvial plain and their courses are all very much alike. Where they leave the hills the banks are high and often gravelly and outcrops of rock are still to be seen in their beds. The height of the banks gradually decreases downstream, but it is not until the western edge of the plain, or eastern limit of the *laha* (which is the local name for the area annually flooded by the backwater from the Irrawaddy floods) is reached that the banks are overtopped in normal floods. It is from this point that the deposition of silt begins; this deposit is naturally greatest along the banks, where the overflowing water first loses its velocity, and gradually

diminishes as the flood water gets further away from the stream. The result of this, as is commonly seen in all alluvial plains, is that the ground surface slopes away from the streams. In the lower reaches, where the banks are low and, therefore, submerged during floods, the stream channel has little stability, and is easily diverted from its course; such diversions are usually caused by breaches in the newly formed low banks, by jams of logs and rubbish, by the accumulation of silt in the stream bed when a freshet subsides or when the Irrawaddy floods cause a general rise in the level of the floods in the Myitmaka depression.

With the exception of the Bilin and Thonze streams, which long ago built up banks of sufficient section to carry their full load right through to the Myitmaka, all the other streams lose themselves in the *laha*. In the past, no adequate control over these streams has been maintained, with the result that there have been continual changes in the lower reaches of the channels, which have traversed the plains in all directions, but these divagations have, at any rate, served to raise the level of the plains. Complaints that the streams were deteriorating were made both by the civil and railway departments, who put forward various reasons to account for this deterioration. Both departments assailed the forest department as being responsible for the evil, and there can be no doubt that the lack of adequate floating control and failure to remove obstructions as soon as possible after formation were contributory causes.

In 1914, after consultation with the late Mr. Samuelson, Mr. Leete decided that the most effective way of overcoming the difficulties that had arisen would be to double-embank the streams at the places where the well-defined channels began to deteriorate. High embankments were, therefore, made at critical places on the four streams, Shwele, Taungnyo, Bawbin and Minhla, before the 1915 rains. These measures were most successful so far as the embankments extended, but no satisfactory channel was obtained below the end of the embankments. In view of this experience the problem of how to carry on the further improvement of the channels, subsequent to the rains of 1915, then arose. Some strongly recommended that the high embankments should be extended, but on the grounds of economy, an experiment was made in 1916 of

constructing low embankments instead of the high embankments tried the previous year. This experiment, or rather the works carried out since this experiment in 1916, proved that high embankments are not an advantage, in fact the reverse has been proved, for in addition to involving considerable capital outlay, many disadvantages, especially to cultivation, follow in their train. Low embankments were constructed on the Taungnyo stream for a distance of one mile in 1916, but this experiment, in itself, proved a failure. It is well known, of course, that when an embankment is overtopped by a flood, scouring first takes place at the outer side of the embankment and gradually works towards the stream; in consequence, the embankments being low were breached in many places during the first jungle flood. These breaches, however, proved to be a blessing in disguise for the experience gained in dealing with them proved beyond doubt the value of bamboo-stake fences in controlling the flow of silt-laden water. This experience induced Mr. Leete, when making his recommendation for the work necessary prior to the 1917 rains, to suggest the systematic application of this method of bamboo-stake fence control, which had been known to the cultivators in these riverine plains for many years. Instead, therefore, of continuing the training of these Yoma torrents with embankments, bamboo-stake fences alone have been used and no embankments whatever have been made since 1916. The continuation of all channels into the *laha* has been brought about and controlled by means of simple bamboo fences. For the purpose of describing the manner in which the "No-Embankment" method is applied, the normal state of any stream at the end of a rainy season may be considered. The condition of the stream is that a channel has been forced to a certain point and kept in place by herring-boned strings of logs. Below this point the channel for some distance is clearly defined in the silt deposits. The small side channels, which break away from the main channel, are blocked with logs. Below this channel there is usually merely a depression in the stiff *laha* clay. The line along which it is desired to form the new channel is then pegged out and usually follows, more or less, a natural depression. All jungle growth to a width of 150 feet on each side of the line is cut down flush with the ground and burned

or cleared away. One hundred feet on each side of the line simple bamboo-stake fences are made. These consist of bamboos, five feet to six feet long and pointed, driven into the ground about nine inches apart and their tops dressed to an even height of about two feet above ground level. These stakes are lashed to a horizontal bamboo with coir rope about six inches from their tops, to hold them in position. Where this fence crosses side channels the bamboos naturally stand higher out of the ground and must be strutted to enable them to withstand the additional pressure at these points. Any bad bends are eliminated by cuts. The low fences are continued just beyond the point which it is anticipated will be the limit of the silt deposit of the ensuing rains. The fences catch up the many kinds of small rubbish brought down on every jungle rise; this forms a barrier which checks the flow of water and causes the silt to be deposited beyond it. In this way each flood serves to increase the deposit of silt and thereby heighten the banks now forming, as well as to raise the level of the surrounding country. It will thus be seen that the channels formed are not made by scouring a bed but, on the contrary, the stream is induced to deposit its silt evenly along its course and to raise banks for itself. Each successive rise further heightens the banks and lessens the overflow, thereby leaving more water to flow further downstream to continue the establishment of banks and channel there. Various complications ensue if the high banks are extended right down to the Myitmaka, so when all the reclamation is done on one line the stream is diverted on to a new course more or less parallel to the old one, and the stabilizing process is repeated, the result being the gradual and methodical reclamation of the deltaic area where silt used to be deposited at random. Wide flat banks are being built up by the streams and along these banks cultivation of paddy has now been rendered possible where a few years ago annually inundated scrub jungle was the only vegetation. Furthermore, this new cultivation is permanent and free from danger from all but the highest of Irrawaddy floods, while the margin of absolute safety is annually being moved westwards. The experience gained during some 25 years of work in this area has enabled better methods to be adopted, resulting in a considerable reduction in the cost of timber

extraction across the *thegaws* or shallows. These shallows occur annually and are caused by the deposition of silt where the heavily silt-laden jungle floods meet the backwater of the Irrawaddy in the Myitmaka Basin. The training of these heavily silt-laden Yoma torrents to provide for the cheapest possible transport of timber has now become a matter of routine.

LAND OF HOPELESS GLORY—I

By E. C. Bor

More than two thousand years ago, King David psalmed his craving for "the Hills from whence cometh my help."

So, in India from the month of April onwards we "lift up our eyes unto the Hills" and dream of the snow that, far above us, mocks the furnace of the plains. This year the Director of Weather Operations began stoking his furnaces a month earlier than he had any right to do. We had counted on getting the unpleasant stages of our journey finished before the real hot weather had begun. But somewhere up in Heaven (or down in Hell) there must have been a cackle of laughter as we arranged our dates, for they had fixed it so that every step of the way shoud be blazing dusty purgatory for most of the first three days. We left our home in a train that was a blazing box of roasting smuts, and we left Pathankot the next morning in a lorry that made you think of the tanks in the Western Desert.

The road that goes to Kulu is the lorry-driver's delight. The driver's idea is to linger at every gate on the road, dawdle over a cup of tea and a gossip until the last possible moment, and then go off, driving like hell, cutting corners, bouncing over potholes, swaying on one wheel above yawning chasms, and charging along the face of crumbling cliffs where notices warn you to "Beware of Falling Rocks!" In this way we careered through the heat to Palampur and thence, next day, to Mandi.

Mandi Rest-house is a well-appointed place with tiled bathrooms and running water, and a *khansama* always ready to supply a meal at short notice. But it is a hot and stuffy place and, after

"We lift up our eyes unto the hills."

an early dinner we decided—as we seemed to be alone—to sleep on the veranda. No sooner had we stretched ourselves upon our beds than a party of four people arrived. That seems to be the trouble with the rest-houses all along this route. You can never count on getting the place to yourself. You arrive to find the house all clean and empty, and you spread out your belongings, and get out a book and prepare to enjoy a rest. And then a car or a fleet of cars arrives and disgorges a jolly party of friends who don't mind "doubling up a bit" and who think "roughing it" all part of their holiday fun. Which is all right for the jolly party, but all wrong if you happen to be a couple of surly folk in search of solitude.

This party that broke in on us at Mandi consisted of two young couples who certainly tried their hardest not to disturb our two selves prostrate upon the veranda, but the new arrivals also decided to sleep out there, and soon there were six of us stretched out in the stilly heat of the veranda. After a while a wind rose, and a dust-storm blew and so smothered us in dust that I wondered if we would all have to be dug out with spades next morning. After the wind subsided a donkey started braying. I do hope donkeys are happy when they bray. I don't think anyone else is. When the donkey tired of braying one of our fellow-sleepers started snoring, and he snored all night until, at 5 A.M., his snores were jammed by the sudden ferocious crowing of a cock that stood flapping its wings on a rock just behind us. So we called for our tea, and got away from Mandi as early as we could.

On that third day of our journey we climbed up above the Beas gorge and into the Kulu valley where the road winds gently through Kulu's lovely orchards, meadows, streams and flies. One can't ignore the flies. They are the curse of the Kulu Valley. Without wire netting in doors and windows they make your house uninhabitable; wherever you go out of doors they come swarming round you in clouds; you find black swarms of them buzzing round you even as high as 9,000 feet among the deodar forests. In fact, we decided that, to get above fly-level, you must go up to 11,000 feet. Never go to Kulu without a fly-flap and a flit-pump.

That day we reached Manali and the end of our lorry-journey. I think that Manali is one of the loveliest places in the world—

Manali with its rivers and streams and water-meadows, its whispering forests of deodar, spruce and pine, and the snow peaks and crags that guard the valley high above the forest. If, as in our case, Manali is merely a halt on your way to the barren country beyond the Rohtang Pass, make the most of it while you can, for here at this far end of the Kulu Valley is the last that you will see of familiar, kindly beauty. Up to Koti (eight miles above Manali) the scenery becomes wilder. (See Plate 18.) The great craggy mountains close in upon you, their cliffs scowling down at the Beas as it roars and plunges over boulders. About three miles above Koti you come out of the forest; leaving the Beas to thunder unseen between great crags that draw together to form terrible gorges, and here you leave behind you the glades and meadows and orchards and the brave show of deodars marching like regiments up to the Alpine meadows. Five miles of weary climbing lie before you, your path zig-zagging up and over the boulder-strewn turf towards the Rohtang Pass. One has left the forest and the meadows behind, and one has also left the flies—all of them in Koti Rest-house which contains more flies than any other confined area in that district.

We crossed the pass on the first of June before the full glory of the Alpine meadows had begun. There were plenty of flowers, however, splashing colour amongst the green of grassy slopes lately freed from snow.

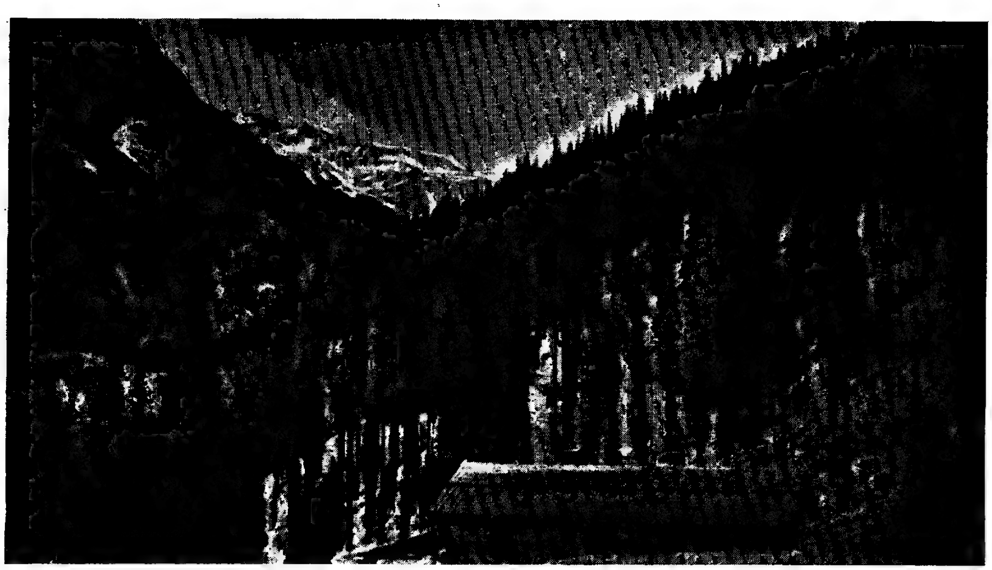
With or without flowers the Rohtang Pass is always beautiful (see Fig. I, Plate 19). And it is a satisfactory sort of pass. If you aren't used to such altitudes the last five hundred feet or so are heart-breaking, but once you're up you know you're up and it lies before you—a more or less level pass between higher rising hills leading you onwards till you stop to gasp at what lies before you on the other side.

Three thousand feet below you lies the narrow valley of the Chandra river walled in by a great range of snowy mountains, the whole world before you a wilderness of crags and glaciers—A LAND OF HOPELESS GLORY. All the glory of unsurpassed beauty lies before you, yet a hopeless kind of glory, for those vast crags and glaciers and distant peaks of snow hung like a threat above the barren slopes of scree pouring down to the valley.

Fig. I

Manali

Fig. II



Koti

The northern slopes of the Rohtang are threaded with streams and waterfalls, and for six more miles the mule-track zig-zags down among rocks and meadow-slopes, down towards the Chandra Valley and the village of Khoksar where the Rest-house and the serai crouch side by side under the shadow of a huge rock. (Fig. II, Plate 19.)

After the rich loveliness of Manali, Khoksar seems a desolate and inhospitable place. There is no compound round the rest-house —just the barren, boulder-scattered valley through which the grey waters of the Chandra go plunging and roaring down.

All day long at Khoksar a wind blows through the valley. The wind moans and roars round the house and when you go outside it stings you with gritty dust. From the jagged mountains of Spiti to the glaciers above the Chenab, our view extended perhaps for 40 miles. In all that vista we could see only two trees, two lonely, wind-bent birches.

Sissu (8½ miles further down the valley), whither we moved next day, is in every way a better place than Khoksar. The village is planted round with willows, and there are meadow glades and fields, a grassy compound round the rest-house, and a shallow lake lying amongst the trees that fringe the river.

We were told that the lake was full of "sunshine trout," but we didn't see any specimens of this cheerful-sounding fish. Nor did we see any "rainbow trout."

Between Sissu and Ghondla the scenery is superb. Tremendous slopes of scree pour down from the roots of crags that have been carved into fantastic pinnacles by the action of ice and avalanche.

One such crag was like an immense cathedral rising high above fan-shaped slopes of scree. Its vast nave with gothic windows and buttresses rose black and proud—tremendous—high above the valley. Its great "west door" tapered to a spire 17,000 feet high piercing the clouds that moved in rags of mist across its roof. Yet, when we passed a mile or so beyond, we saw that the Great Cathedral Rock was no more than the upthrust edge of a glacier that came squirming down from snowfields higher up.

We sat down by the roadside to look at the beauty of those crags. Before our eyes we could see "geology in the making," for

each successive spur of mountain was set out like a plan to teach the elements of rock history. Far above all day the snowfields, apparently undisturbed by the fierceness of the June sun. Then came the glacier grinding its way over the rock, cleaving a deep gorge between ice-scored cliffs. Next came fan-shaped slopes of scree and débris left behind by avalanches, and deposited by the glacier as, in the course of centuries, it gradually retreated. In the long steep slopes of scree one saw the final state of disintegration before a soil formed on which the first adventurous plants might struggle to take root.

As we sat watching the glacier, little drifts of snow kept falling from above and dropping to a ledge of rock 600 feet below.

Suddenly we heard a rumbling noise that swelled and filled the valley, and we saw a vast mass of snow gathering speed as it moved across the glacier, slipping towards those cliffs of ice that hung above the rocks. Then the whole valley shook with the thunder of the avalanche. Hundreds of tons of snow and ice crashed on to the ledge of rock 600 feet below. The whole huge mass burst like a bomb, and the crags and mountains became veiled in the smoke of its explosion. As the smoke cleared away, we saw the rest of the avalanche sliding to the rim of the rock-ledge, then swiftly over, dropping another 600 feet till it fell on the screes and came creaming down towards the river, leaving behind it a trail of débris to mark another moment in the evolution of the mountains.

At Ghondla, our next halt, those mountains rise in a great wall sheer 11,000 feet right opposite the rest-house. There is an ancient castle here, still inhabited by the Thakurs of the district. (Fig. III, Plate 19.) The whole of the Chandra Valley (which ends not far beyond Ghondla) sings with the voice of streams and waterfalls.

Seeing how well-watered it is, one wonders that there are so few villages and so little cultivation. Apparently, however, the winter is too severe, the snowfall being exceedingly heavy and the avalanches a constant danger. Mr. Peter, of the Moravian Mission, tells how he came to Khoksar one winter and sought in vain for the rest-house. Eventually he found that he was walking about on top of it, the whole house being completely buried—chimney and all—under thirty or forty feet of snow.

Fig. I

Mist on the Rohtang Pass

Fig. III

GHONDLA. The Thakur's Castle

Fig. II

Khoksar

Not very far from Ghondla there is a place where a tremendous landslide, three or four years ago, carried away an entire village, and partially damned the Chandra. Disaster also comes to that valley from the shifting of the vast glaciers that hang between the mountains. In 1836 one of these glaciers moved downwards and caused a stoppage in the river whose waters rose and drowned an entire village. To this day one can see the marks of this disaster at a level of 50 feet above the usual level of the river.

In ancient days Tartar invaders, sent by Genghiz Khan, were overtaken by the winter in this valley, and among the caves and rocks may still be found occasional weapons that show where their owners perished in the snow.

After Ghondla one sees no more of the crystal streams and waterfalls that bejewel the harsh grandeur of the Chandra Valley.

From Ghondla onwards the scenery becomes more and more dessicated, the only water visible being the muddy waves of the Chandra as it hurries to join the tumbling waters of the Bhaga river, the two together charging off down the Chamba Valley, forming the headwaters of the Chenab.

From Ghondla to Kyelang the road is long and dull and weary, with very little shade and a great deal of dust, and—after the majesty of the Chandra valley—the scenery is monotonous and uninteresting. One plods along, seeing in the distance the flat-topped houses and scalloped fields of Kyelang, and one despairs of ever reaching them. But at last, choked and powdered with dust, one does eventually stumble into Kyelang, the capital city of Lahoul. As we intended to make our headquarters there and to settle down for at least two months, it may be as well here to give the weary reader a rest before going on to describe all that we saw and learned in those two months in Lahoul.

(To be continued.)

NOTES ON *PYNKADO—XYLIA DOLABRIFORMIS* AN EXOTIC IN ASSAM.

BY R. N. DE, I.F.S.

The introduction of Pynkado in Assam has an interesting history. In 1925, the writer took over charge of the Sylhet Division where any kind of forest produce could be sold, but the Reserves or the Unclassed State Forests did not contain much valuable constructional timber like sal and other hard woods and we were putting out plantations of teak, *Gmelina arborea, Artocarpus chaplasha*, etc. Inspection of the timber depots in the Division revealed that a wood, locally called *loha-kath*—"iron-wood," was very much in demand and it was obtained in Sylhet, as well as in the adjoining districts of Tippera and Mymensingh from Dacca, at a price equivalent to or often in excess of the price of sal (*Shorea robusta*). Enquiry was set on foot to trace out what this *loha-kath* was and its source of supply and eventually it was found to be Pynkado—*Xylia dolabriformis* of Burma.

Nothing was known regarding the soil, climate and altitude of Pynkado and its introduction to Assam was never thought of. About the cold weather of the year 1926, Mr. Atkinson of Burma who came to Dehra Dun on deputation to officiate as Forest Entomologist, visited our plantations at Lawacherra in the Bhanugach Reserve of the Sylhet Division in order to devise control measures for teak and *Gmelina*-borer—*Dihammus cervinus*, which was causing much damage to our new plantations. The writer was then the Divisional Forest Officer, at whose instance the visit was paid. In course of conversation, Mr. Atkinson gave all information regarding the Pynkado and conditions seemed to suit the growth of the species in Lawacherra. On enquiry regarding the seeds, Mr. Atkinson told the writer that he was shortly going back to Burma and he would send some seeds from the Insein Division where he was expecting to be posted. He redeemed his promise and kindly sent some seeds for trial. This was the starting point of the introduction of Pynkado in the Sylhet Division.

On receipt, the seeds were sown in a nursery and gave nearly cent. per cent. germination. Some of the seedlings were transplanted in the forest with *Gmelina arborea*, while others were made into stumps and planted on both sides of the approach road to the Forest Inspection Bungalow at Lawacherra. Nothing in particular was done to encourage the exotic in subsequent years and those in the forest were getting suppressed by the fast-growing *Gmelina*, till the writer visited the forest again in 1938 and got them freed. Those on the roadside have made most rapid progress and the best stem has got a girth of 4 feet 1.25 inches in 14 years, a growth which can compare very favourably with the 1st Quality Pynkado in Burma.

The species has been introduced in the Cachar Division lately and there also the growth has been very rapid. The seeds germinate freely, giving over 90 per cent. of seedlings and the plants do well in direct sowing, transplanting and stump-planting. Stump-plantings of 1938 have grown upto 22 ~~inches~~ now (August, 1941) and it fe is obvious that no weeding is needed after the third year.

Timber of Assam Pynkado has not yet been tested in Dehra Dun regarding its quality, but a house post made out of a windfallen tree two years ago has not yet been eaten by white ants or borers. The tree seeds within 12 years of its life and germination of such seeds is also over 90 per cent. So far no borers, defoliators or other pests have made their appearnce on this exotic, but the writer has discovered one *Gmelina Loranthus—Scurrula parasitica* Linn, on a Pynkado tree and that shows the need of vigilance on our part.

BEAUTIFUL TREES: THEIR PLANTING AND CARE

[*Being the report of a Talk by K. P. Sagreiya, Esqr.,* I.F.S., *Silviculturist, Central Provinces and Berar, held under the kind patronage of His Excellency the Governor, Central Provinces and Berar, and Lady Twynam, in the University Convocation Hall, Nagpur, on Tuesday, the 15th July,* 1941.]

BY WALI MOHAMMAD, *Forest Ranger.*

This talk was arranged with a view to stimulate the interest of the citizens in ornamental trees and then appeal to them for

contributions to the Nagpur Planting Fund started by Government. The main feature of the Talk was the display of natural-colour paintings of flowering branches and "Dufaycolour" transparencies of entire trees at their best on a specially prepared "Silver" screen. I give below the Talk The photographs are from Mr. Sagreiya's book entitled "Ornamental Trees: Their Planting and Care." (C. P. Forest Bulletin No. 4, 1941).

THE TALK

YOUR EXCELLENCY, LADY TWYNAM, LADIES AND GENTLEMEN— As announced, this evening I propose to say a few words on the planting of trees for ornament, a subject in which I am sure all of you are interested; if not in the cultivation of trees, at least in their artistic value.

For my part, although I readily consented to undertake this task, I must confess I did this purely with a selfish motive, namely, to popularise a pet hobby of mine, for which I have often been ridiculed as running after a mirage. If, at the end of the talk, I have succeeded in converting the critics and convincing them that, if there is the will and perseverance, we can certainly create an oasis in the dreary desert of our environment, I will consider myself amply rewarded. If I do not succeed, it will not be because I have tried to prove the impossible, but only because I am ignorant of that subtle art of making a speech, on which these days depends the success of most missions.

How I wish that I could make up for this shortcoming by presenting before you the living and lively trees themselves and then allow them to allure you by their exquisite form, their refreshing and vivid colours and their intoxicating fragrance! But, unfortunately for me, the trees are not so subservient as you and I are. They not only will not come to us but they also refuse to put on their best garb when we want them to.

As the next best alternative to relieve you of the tedium of having to listen to an unimpressive talk, I have invoked the aid of the camera and the brush. I hope to show you a few photographs and paintings of some of the trees, captured in their gala season,

But before I do this I will crave your indulgence for a few preliminary remarks.

Every one of you must have noticed that soon after our none-too-long winter is over, and in some cases even earlier, our land scape, which so far, if not resplendent with colours, at least contained much verdure, rapidly begins to assume a barren and bleak appearance. The few trees and shrubs—hardy, that have successfully withstood the onslaught of man, and which had so far concealed their deformity by donning the robe of fresh foliage, begin to get bare, and, as it were, vie with the elements to make conditions as unbearable as possible to man and beast alike; presumably to wreak vengeance on them for their wantonness and callous disregard.

To refresh your memory I will show you one such scene—A Treeless Road (See Fig. I, Plate 20.) This is a stretch on the Great Northern Road, protographed on 20th May. Imagine yourself travelling on this road and having a breakdown in the middle of the day when the thermometer registered 113 degrees in the shade, and you will need no persuasion on my part to convince you of the need for planting trees along roadsides. How you would wish that there were at least one green tree to make your stay, until help arrived, less irksome. For instance an avenue of jamun, an evergreen tree (see Fig. II, Plate 20).

Before I start my bioscope—where I will show you trees in their glory and not in their misery—by way of contrast, and particularly to bring home to you the need for concerted efforts, I would say a few words about the ugly features which have been responsible for the failure of efforts made in the past.

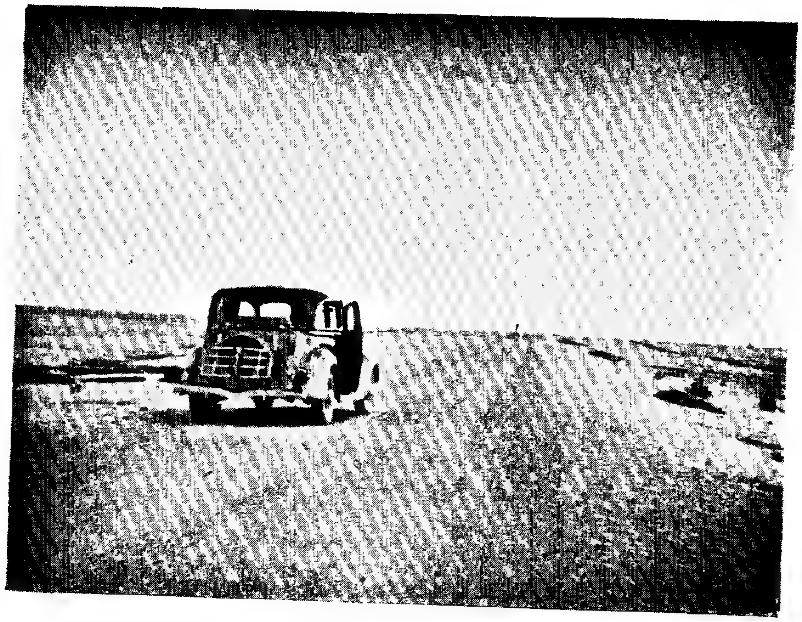
Fig. I, Plate 21, represents a heavily lopped tree. This is the familiar *pipal* tree—or rather the ghost of one. It is sacred to the Hindus, so much so that it is a job to get it felled in the forest when not required. And yet, because its succulent branches and leaves are a good fodder, it is ruthlessly hacked. Even in the most heavily-guarded places it does not escape the pilferer's axe. This particular tree stands in no less protected a place than Government House itself, It may interest you to know that in this particular case the culprit was caught redhanded and prosecuted. The

result was a snub to the Arboriculturist. The magistrate summarily dismissed the complaint as too trivial, because, he said, the leaves removed were not worth more than a few pice. If the learned magistrate is here, I would like him to compare this picture with the one in Fig. II, Plate 21, and then judge for himself how far the offence was a trivial one or the complaint a frivolous one. This is how the tree woud have looked if the lopping had been prevented. This tree stands on the lawn in front of the old High Court Building.

To cite another instance, you must have noticed how *babul* trees have been recklessly pollarded along certain highways. Some two years ago when I noticed such damage I made enquiries and, to my horror, I was told that this was done by the P.W.D. to get firewood to feed the road rollers, and thus save money on the purchase of imported coal. This is *Swadeshism* with vengeance! It is sheer Vandalism! I am glad to say that as a result of my efforts, an order has now been issued by the Chief Engineer that no roadside tree may be cut without the written sanction of the Deputy Commissioner.

I cannot help mentioning another instance which has thwarted my efforts, and about which I feel very sore. As probably you are aware, some four years ago the Town Improvement Trust contemplated an ambitious programme of tree planting. To help them in this work I volunteered to transfer to them a small nursery of plants, that I had started on my own, and also offered to give them general guidance without any obligations. Their tree-planting work, however, has been held up. Last year, therefore, I tried to sell as much of their stock as possible by persuading friends in Amraoti, Jubbulpore and even Bastar, and also locally. The stock that was left unsold was fast getting pot-bound and, therefore, I suggested that by way of a gesture the Trust might make a gift of it to Government, in response to our ex-Governor, Sir Francis Wylie's appeal to the citizens for co-operation in the work of tree planting to beautify our town. Incidentally this would have saved the Trust a monthly expense of 25 rupees on maintenance. For some mysterious reasons the Trust authorities did not even care to

Fig. I



A Treeless Road. (Portion of the Great Northern Road.)

Fig. II

Jamun (Eugenia jambolana) Avenue. (In Nagpur Civil Station.)

Fig. I

A heavily-lopped Pipal Tree.

Fig. II

A well-developed pipal tree. (Photographed on the same date as Fig. I above. This tree has escaped the pilferer's axe.)

acknowledge my letters. Apparently they do not mind if their plants perish and they go on spending money on their upkeep but they would not give them away. They have lost a golden opportunity of making a virtue of necessity.

I will give you just one more instance. The other day I caught a man breakng twigs off a *neem* tree in the Civil Station. On questioning him, to my chagrin, I was told that he was collecting *datuns* for his *Sahib*. Fortunately, the *Sahib* happened to be a friend of mine and so I approached him. He assured me that he had never asked the servant to get any *datuns* for him. Obviously the servant merely wanted to impress on me the magnitude of his mission. I shudder to think what the consequences would have been if the master had taken the same attitude as the learned magistrate.

I think I have already tried your patience and possibly also annoyed some of you. Forgive me if I have, and put it down to my enthusiasm. I will now try to make up for it by showing you what we could achieve by way of well-planned planting. For convenience, I will describe species in the order in which they flower during the calendar year.

Kachnar flowers in February. *Bauhinia variegata* is the scientific name. *Bauhinia* is in honour of John and Casper Bauhin, German botanists of the 16th Century. The two leaflets united to form a single leaf suggest the twin brothers united in the study of Botany. *Variegata* refers to the colour of the flowers. *Kachnar* is from Sanskrit *Kanchan* meaning gold, and refers to the Indian custom of exchanging its leaves on the Dasera day as a token of friendship, in lieu of gold. It is a common small tree of our forests. Extremely handsome when its large fragrant flowers appear on bare branches.

Gliricidia maculata, or The *Madre* Tree is an exotic. *Gliricidia*, rat-destroying, in reference to seeds which are believed to be effective as a rat poison; *maculata* means spotted—describing the character of the undersurface of the leaves. *Madre* means mother in Malayalam. It is so called because the species is used as a nurse for coffee. This tree is growing very well in Nagpur. It flowers

when practically leafless in February. It is very fast-growing but somewhat branchy.

The familiar *semal, Bombax malabaricum,* is named from the Greek *Bombax* silk-worm, which is reared on certain species of the family; and *malabaricum,* probably because the first specimen to be identified was sent from Malabar. It flowers in March.

Gongal is a common forest tree. Its botanical name is quite a mouthful, *Cochlospermum gossypium. Cochlospermum* describes the twisted seed, and *gossypium* refers to the floss obtained from its fruit. The tree is a striking object in the forests when in blossom in March.

Palas (*Butea frondosa*) is very common. After it the famous battle of Plassey where in 1757 Robert Clive defeated the army of Siraj-ud-Daula takes its name, because it was fought on the plains abounding in this species. A forest studded with *palas* in flower in March, appears as if on fire, justifying the name of Flame of the Forest given to the tree. The botanical name is in honour of John Stuart, third Earl of Bute, munificent patron of Botany in the 18th century; *frondosa* in Latin means leafy and refers to the general appearance of the tree when in leaf. You may be interested to know that besides the common species with red flowers, there are "sports" bearing bright-yellow, apricot and also pure white flowers. I have collected seeds of these sports and raised plants. It remains to be seen if they breed true.

Next comes the common *Panjra, Erythrina suberosa. Erythrina* is from the Greek *erythros,* red, in allusion to the bright colour of the flowers; *suberosa* in Latin means corky and refers to the bark of the tree. It is called the Coral Tree because of the resemblance of the flowers to corals. There are species with dark-maroon and also pure-white flowers, which appear in the hot weather.

There is an exotic called *Spathodea campanulata.* It is growing very well in Bangalore, Bombay, Chikalda and also in Nagpur. It flowers in March. The common English name is Fountain Tree because the flowers contain a liquid and the children use them as squirts.

Then there is the *Sacred Barna,* called *Cratæva religiosa,* after Cratevas, an obscure writer on medicinal plants in the beginning

of the 1st Century B.C.; *religiosa,* because the tree is sacred to the Hindus and Buddhists. The flowers are green turning to lilac-white and then to yellow before fading. Such variegation makes the tree strikingly attractive during March.

The famous *Ashok* (*Saraca indica*) has inspired Indian poets to wax eloquent. The flowers appear in great profusion in March and are extremely sweet-scented. Roxburgh, the famous botanist wrote: "When this tree is in bloom, I do not think the entire vegetable kingdom affords a more beautiful object."

Tecomella undulata is a tree of the drier parts of the Punjab. The generic name is derived from the Mexican name of the plant meaning a floral-receptacle in allusion to the vessel-shaped flowers; *undulata* refers to the wavy margin of its leaves. It is strikingly attractive when the large inodourous flowers appear, I presume, in the hot weather. I have a tree which has not yet flowered.

Cassias are the most renowned genus of flowering trees. One species is called *Cassia javanica* as it is a native of Java. It is growing very well in Nagpur and flowers during April-May. There is also a Cassia from Burma, called *Cassia renigera*. *Renigera* means kidney-bearing, and refers to the shape of the stipules. It is very similar to the previous one except that it is a smaller tree and the arrangement of flowers on the branches is somewhat different. It flowers in April-July. Then there is our indigenous Cassia *C. fistula,* or *amaltas,* generally called Indian Laburnum and more aptly described by the Americans as *Golden Shower*. It flowers in April-June. There is a late flowering variety with whitish-yellow, very sweet-scented flowers in shorter racemes.

Sterculia colorata is a rare tree of the Central Provinces forests. It is named from Sterculius, a god, derived from *stercus,* dung. The Romans in the height of paganism deified the objects of their greatest dislike and most immoral actions. Thus they have got, Sterculius, Crepitas, and goddesses Caca, Pertunda, etc. The name is given to this genus because the leaves and flowers of some species are very foetid; colorata means coloured, referring to the orange-red calyx of the flower. It can grow even where rock is exposed. It is strikingly attractive when in bloom in May-June.

The Jarul tree of Assam forests (*Lagerstrœmia flos-reginæ*) flowers in May. It is named in honour of Magnus von Lagerström, a friend of Linnæus; *flos-reginæ* means the queen's flowers. There is a variety with dark mauve flowers.

Jacaranda ovalifolia blooms during April-May. *Ovalifolia* means with oval leaves. Origin of *Jacaranda* I have been unable to find out. The flowers are more bluish than shown in the painting before you. It may interst you to know that in our climate with very bright blue skies no indigenous trees produce flowers which are blue, possibly because they cannot readily attract pollinating insects. This exotic tree, therefore, deserves to be popularised. There are only two other trees with blue flowers, which I will show you presently.

Dikamali or *Gardenia lucida* belongs to our dry forests flowering in July. *Gardenia* in honour of Dr. Garden of Charleston, U.S., a correspondent of Linnæus; *lucida* means bright and with a shiny surface. Reference is to the leaves. Its glory is short-lived but the flowers are very pleasantly scented.

Gulmohurs have done well in Nagpur flowering from April to late July. The common English names are the *Flamboyant Tree* or *Gold mohur.* The scientific name is *Poinciana regia* in honour of M. De Poinci, a Governor of the West Indies and a patron of Botany; *regia* in Latin means royal. The correct Indian name should be *Gulmohur* and not *Gold Mohur,* meaning flowers (gul) like a gold coin (mohur). The Tamil name, however, is *Mayuram* which in Sanskrit means a peacock. You might be interested to know that there is a tree in Chindwara which bears apricot-yellow flowers without any suggestion of red. This tree, however, does not produce any seed.

Colvillea racemosa, is named in honour of Sir Charles Colville, Governor of Mauritius. *Racemosa* refers to the arrangement of the flowers. It is a tree much resembling *Gulmohur,* and also comes from Madagascar. I have planted a few of these trees in the new High Court compound where they are growing very well so far. I believe they will flower in July.

Gulchinis, wrongly called *Champas,* flower from April to July. Europeans call them *Frangipani* or *Pagoda Trees.* The botanical name is *Plumeria acutifolia.* *Plumeria* after the Franciscan traveller and French botanist Charles Plumier; *acutifolia* refers to the tapering pointed leaves. The Sanskrit name is *Kshirchampak.* Besides these two species, there are several others bearing pure white flowers of different sizes.

Peltophorum ferrugineum is an exotic having the tongue-twisting name. *Peltophorum* is Greek meaning shield-bearing in allusion to the shape of the pod; *ferrugineum,* of the colour of iron-rust, in reference to the colour of the pods and the tender shoots. Hence its name, *The Rusty Shield-bearer.* It is growing extremely well in Nagpur and deserves to be popularised. It is evergreen and is very ornamental in flowers which are also sweet-scented. It flowers in October and again in March. The tree is also strikingly attractive with its bunches of bright-red pods.

Solanum macranthum or *The Potato Tree* is the other blue-flowered tree or rather a large shrub. *Solanum* is the classical name of black pepper; *macranthum* from the Greek *macros,* large and *anthos* flower, in reference to the size of the flowers. This tree is in bloom almost throughout the year, and particularly during the rains.

Thespesia populnea is an evergreen tree, sporadically flowering throughout the year. It belongs to the same family as our vegetable *Bhindi* and is, therefore, sometimes called *The Bhindi Tree.*

The third blue-flowering tree is *Lignum vitæ.* It has a botanical name difficult to pronounce, *Guaiacum officinale. Guaiacum* is derived from the Spanish name *Guayaco*; *officinalis* means officinal, i.e., used or recognised in pharmacy. It is rather slow-growing and is best grown as a shrub. It flowers in March and again in November.

Oxydendron arboreum is an American tree commonly called *The Sorrel Tree.* The young spring foliage is extremely attractive.

There is a Persian tree called *Parrotia persica,* after F. W. Parrot, a German naturalist. The autumnal colouring of the leaves before fall is very fascinating.

[At this juncture an interesting set of photographs was shown to the audience.]

I now come to the main purpose for which I have troubled you this evening, namely, to appeal to you to co-operate in this work of beautifying our town by planting trees. Last year our *ex*-Governor, SIR FRANCIS WYLIE, who was anxious to place arboricultural work on a sounder footing, very kindly ordered that whatever funds were then available for planting trees in Nagpur, and for their upkeep, should be placed at my disposal and the small staff asked to work under my guidance. And now Your Excellency has been pleased to encourage this tree-planting drive by honouring us with your presence at this talk and by giving me other facilities. I have made the most of these facilities and raised a fairly large stock of some 50 different ornamental species for planting out immediately. These are plants waiting to be planted in your homes. I have over 1,500 of them.

But this is not enough. The main items of cost are not the plants but the digging of pits and the subsequent tending of plants for 2 to 3 years until they can take care of themselves. It is here that your co-operation and help are sought. If residents and heads of offices could make a small contribution the Arboricultural Branch could see to the planting and tending of the trees and I am not exaggerating when I say that in less than ten years, the face of Nagpur could be transformed beyond recognition. With as small a contribution as one rupee per month per house, we could undertake to plant and look after as many as three to six trees of your choice depending on the soil and species, provided that you could get them watered, for say two seasons. Is it too much to expect? You could take it that you have raised the pay of your *mali* by one rupee and forget all about it. In course of time you will not have regretted this investment. I dare say you are spending much more than this in trying to grow treees yourself. Why not let the Arboricultural Branch help you and save you all the worry? In this connection, I have great pleasure in announcing that on behalf of the Nagpur Municipality my friend Mr. Bambawale has promised a donation of Rs. 500 to be utilised for clearing the town of all obnoxious plants and for planting ornamental trees in suitable places.

For the enthusiastic amateur, I have endeavoured to collect as much information on the subject as I could in the time that I have been able to spare. This has been printed as a Bulletin which has been priced at rupee one to cover the cost. The Government Press has kindly brought copies for sale here in this room. They can also be had at the Government Press Book Depôt.

And before we disperse I will show you a few more select slides which I have deliberately kept for the end so that their impression may remain on your minds after you have left the place. I have not been able to collect very many, because this is the most expensive part of my hobby.

(*Slides shown as follows.*)

This extremely graceful tree is called *Acacia auriculiformis.* It has lance-shaped leaves—actually they are leaf-stalks—on weeping branches and very fragrant yellow flowers in tassels in October which are used as the base of Parisian scents. *Auriculiformis* is from Latin *auricula,* the lobe of the ear; *forma,* means shape, and the reference is to the flat leaflike phyllodea. This was the only tree in Nagpur standing on a house plot in the Craddock Town. It was cut down recently and on its ruins now stands a nondescript cottage. I have several *bachchas* of this.

This is *Tecoma stans,* commonly used as a hedge plant. This particular tree is a freak in which the flowers appear in large honeycomb-like bunches which make it extremely attractive in April and October. I have several plants raised from the seed of this particular tree which I found growing in Dehra Dun.

This is a Mexican tree allied to our *semal,* called *Chorisia speciosa.* It flowers in October. I have a few plants of this. The species is named in honour of Ludwig Choris, an artist of Kotzebue's expedition in the 18th century, *speciosa* means beautiful, and refers to the flowers.

This is an evergreen timber tree of Uganda, called *Markhamia platycalyx.* It is named in honour of C. R. Markham who introduced the cinchonas into India; *platycalyx* refers to the broad, cup-shaped jointed sepals.

If you have noticed the captions and followed my description, you must admit that it *is* possible to grow successfully a variety of ornamental trees in Nagpur: shade trees, large or small flowering trees, trees with scented flowers, in fact, trees suited for every place and purpose. You could have shady avenues, avenues with a vivid display of colour in any particular season, a clump of trees some of which are always in flower or leaf all through the year. There are also trees that could protect your houses against the hot afternoon sun in summer; trees suited to the very worst soils and situations, and so on. I have dealt with all these aspects of the subject in the Bulletin which I mentioned a few minutes ago. A start with planting has already been made where you can see how the plants are growing, for instance, in the compounds of the Government House, the new High Court, the Technological Institute under construction and the newly-built Central College for Women which, with its setting of flowering trees in a few years' time should become one of the most picturesque spots of Nagpur.

That is all I have to say and show you. And now I must thank you all for the trouble you have taken to come here, and also thank you in anticipation for the help I am sure you will give to beautify our town and make it the envy of the visitor from less picturesque spots.

YOUR EXCELLENCY, LADY TWYNAM, Ladies and Gentlemen, I thank you.

H. E.'s SPEECH.—His Excellency the Governor, making a strong plea to make Nagpur a beautiful city, said: "Mr. Sagreiya is an enthusiast and always interesting to listen to. I hope that the P.W.D., the Nagpur Improvement Trust and the Governor will bear in mind what Mr. Sagreiya has said. India grows some of the most beautiful flowering trees and it is his ambition to see them massed together. Nagpur has an undulating surrounding and if every householder were to plant one flowering tree it will create an inspiring scene. SIR FRANCIS WYLIE has initiated the movement and he had taken it up in the interest of the citizens of Nagpur. Very little money is required and Mr. Sagreiya would provide us with flowering trees."

CHIEF CONSERVATOR'S CONCLUDING REMARKS.— The function came to an end after Mr. C. M. Harlow, Chief Conservator of Forests, thanked His Excellency, Lady Twynam, and others on behalf of the Forest Department for attending the Talk. He hoped that the aim behind the Talk will be soon realised.

APPEAL TO THE CITIZENS

The following Appeal has been issued by the Chief Conservator of Forests to the citizens of Nagpur for collecting funds.

For Brighter Nagpur, Plant Ornamental and Flowering Trees.— It is the duty of every citizen of Nagpur to do everything in his power to improve its beauty and amenities by removing unsightly weeds, shrubs and decrepit trees, and by planting ornamental and flowering trees along roads, and in compounds and open spaces. The Seminary Hill—a bleak bare ridge some 30 years ago—gives some indication of what can be done by planting trees and keeping them in good order.

In order to help the public in discharging this civic duty, the Nagpur Civil Station Planting Fund has been started, applicable to the Civil Station only in the first instance. It is in charge of the Agriculture Department, with which is associated Mr. K. P. Sagreiya, I.F.S., Silviculturist, who is a keen enthusiast on ornamental tree-planting. Some planting has already been carried out in the Kadim Bagh, the new High Court and the Rao Bahadur D. Laxminarayan Technological Institute.

An appeal is made to every resident of the Civil Station to co-operate in this work by taking a personal interest in keeping his residence free of unsightly vegetation, preventing wilful damage to trees, and by making a small annual contribution of, say, Rs. 10 to the Nagpur Planting Fund.

In return the Arboricultural Branch will arrange to plant two to four ornamental trees in consultation with the contributor in each compound. Tree-guards will be provided. The actual number of trees planted will naturally depend on the nature of the soil and the species selected. As many as six trees might be planted for ten rupees if the resident will help by arranging to have them

watered by his *mali*. The Arboricultural Staff will arrange for such tending as may be necessary. It is open to donors to subscribe only half the above amount, or more, in which case the number of trees would be proportionately reduced or increased.

Apart from lack of proper tending, indiscriminate lopping of trees, browsing, and removal of living bark have been the main factors responsible for the unsatisfactory development of trees planted in the past. The co-operation of owners and occupants of bungalows, and of persons in charge of public institutions will greatly assist in preventing such malpractices.

Mr. Sagreiya has given an illustrated talk on the planting and care of beautiful trees and has written a small booklet for the use of those interested. A copy of the talk is being distributed free of charge, with this Appeal, and the booklet "Ornamental Trees: their Planting and Care," price one rupee, is obtainable from the Government Press Book Depôt, Nagpur.

Residents wishing to join the Nagpur Civil Station Planting Fund are requested to enter their names and annual subscriptions on the attached list, and either to pay the current subscription to the bearer or to send it to the Director of Agriculture. Formal receipts will be sent in due course.

It is earnestly hoped that every resident of the Civil Station, who is proud of his fair city, will join and co-operate wholeheartedly in this Scheme, which aims at making it one of the most beautiful towns in India.

REVIEWS AND ABSTRACTS

SONS OF THE SOIL

[*Studies of the Indian cultivator. Edited by W. Burns. Manager of Publications, Civil Lines, Delhi,* 1941. *Price Rs.* 2-6-0 *or* 4*s.*]

Dr. Burns' idea in bringing out this book of 128 pages was to present a description of the types of the Indian cultivator similar to the types of the Indian army in Edmund Candler's book, "The Sepoy." He is the editor of the book, but is also the author of one of the contributions to this series of brief but graphic vignettes of rural India and Burma written by officers of the Agricultural Department and by Mr. Verrier Elwin. The book is, however, not wholly agricultural fare or wanting in interest and utility to forest officers who spend most of their time in the pursuit of forestry with the "Sons of the Soil."

The most picturesque part of the book is the cover where photographs of the various types of the cultivators are put in assembly, as it were, of the league of rural India, for comparison and contrast.

We visit the home of the cultivator and are treated to intimate details of his life.

MADRAS.—Thus we learn that the *Gvara* ryot of Madras is an expert in the growing of vegetables and sugarcane. In respect of education he is rather backward.

BOMBAY.—The *Kunbi* is the best cultivator in the districts of Gujrat of Bombay Province. He lives in comparatively well-built houses two or three storeys high.

BENGAL.—The Bengal cultivator, it is commonly supposed, lives a life of idleness for six months. Where the land is single-cropped this may be so, but he has a strenuous life where the average holding is less than two acres and two or even three crops are raised in a year.

UNITED PROVINCES.—The *Jat* cultivator of the United Provinces has a high standard of cultivation; a long-standing tradition of hospitality, an independent outlook, directness of speech, and loyalty to one's salt. He is not shy of using appliances when their value has been demonstrated.

PUNJAB.—The *Jats* of the Punjab are the most important of the agricultural tribes of that province. They excel others in crop husbandry, with the exception of vegetable-growing in which the Arain leads. The *Jats* are generally of good physique and are hardy. Tribal instincts die hard and the memory of old family feuds remains ever fresh in their minds.

BIHAR.—The *Koeries* of Bihar are the most advanced amongst the cultivating classes of that province and are simple in habits, thrifty to a degree and masters in the art of market gardening.

CENTRAL PROVINCES AND BERAR.—The *Gond*, *Maria* and *Baiga* cultivators of the Central Provinces often have to struggle with poor rocky soil where only *Kodon* (*Paspalum scrobiculatum*) and *Kutki* (*Panicum miliare*) can flourish, but their characteristic type of cultivation is shifting cultivation. The bulk of the cultivators in Berar are *Maratha Kunbis*. The Berar *Kunbi* is strong, energetic and hardworking. He has a tendency to borrow money without any consideration of his ability to repay. Simplicity in food, dress and manners is his distinctive characteristic.

ASSAM.—The Assam cultivator is simple and straightforward and can only see what lies immediately before him. He does not wish to make what he considers unnecessary

exertion and does not see the necessity of providing against the rainy day. He is usually quite clean and a daily bath is a routine. He is very fond of chewing betel leaves and always grows a few areca palms and betel vines. Some castes are very fond of home-brewed wine, but they rarely get drunk.

N.W.F.P.—The Peshawari cultivator is noted for his hospitable nature and is very fond of tea. Rice, sugarcane and chillies are his main crops. Fruit cultivation is also important. Many fruit trees have been obtained from abroad, e.g., peaches from California, plums from Japan and pears from France.

ORISSA.—The Oriya cultivator of the coastal district is subject to the incidence of malaria and other diseases and suffers from storms, floods and drought. His habits are simple and his requirements few. The unconsumed portion of the rice of the evening meal soaked in water overnight forms his breakfast, as in the case of the *Chhatisgarhi* cultivator of the Central Provinces. Betel leaves and tobacco are indispensable.

SIND.—The Sindhi cultivator in general is trustworthy, honest, hardworking, an early riser and punctilious about his personal cleanliness and appearance.

BALUCHISTAN.—The Baloch cultivator is tall and spare in appearance, temperate in habits and endowed with great powers of endurance. His principal harvests are wheat, barley and *jowar* (*Sorghum vulgare*). A universal characteristic of the Baloch cultivator is the siesta which he enjoys from 12 to 3 o'clock. Another feature of his social life is the daily meeting held morning and evening in each village.

BURMA.—The Burmese cultivator is of Mongolian stock, small and lightly built. The people are colourful in their dress and mix their colours with great taste. Their weaknesses are a lack of control and love of a gamble. The Burmese cultivator has developed a fair degree of

skill in his practice of growing dry crops. He is very much of an individualist and although he will listen to what other people may say, he likes to feel he has taken a line of his own.

This, in brief, is how the panoramic view of the human side of the cultivators of British India and Burma is presented and although the account gives no statistical details of crops and family budgets, it nevertheless is worth reading, as Dr. Burns says, for letting one half of India know the other half.

J. P.

ORNAMENTAL TREES: THEIR PLANTING AND CARE

[*By Kamta Prasad Sagreiya,* I.F.S., *Silviculturist, C. P. & Berar, Nagpur. Published as C. P. & Berar Forest Bulletin No.* 4, 1941, *by Government Printing, Nagpur. Pp.* 1 *to* 68, *with* 5 *illustrations. Price Re.* 1.]

In his preface the author says: "The study of Ornamental Trees—not from books, but from personal acquaintance with the living specimens—is a pastime of the writer, not his profession," and further that "the notes were primarily collected for his own use and are now being published at the instance of Government in the hope that they may stimulate the interest of citizens in this much-neglected aspect of town-planning.

Propaganda apart, the Bulletin fulfils a long-felt demand. The subject-matter has been arranged in a manner that will readily appeal to the uninitiated—a welcome departure from the common run of books on the subject which are either too technical or too verbose, often at the sacrifice of accuracy.

Chapter I deals with general considerations. It begins by stating the main object with which ornamental trees are planted, namely, to appease the æsthetic sense of Man. It is pointed out that the attractiveness of trees depends on a variety of features: some are prized for the continuous shade they give, others for their form, foliage or flowers, and yet others for their fragrance. Every tree does not possess all the desirable characteristics and, therefore, it is essential that if a permanently pleasing appearance is to be

obtained, the species should be carefully selected and then displayed in a judicious manner.

Then follow the instructions to the amateur who is struck by the beauty of ornamental trees which in Somerset Maugham's words "batters him and stuns him and leaves him breathless" and creates in him, in Mr. Sagreiya's words, "an innate desire to bring the glory close to his home." The author rightly advises the amateur to ascertain the correct scientific name of the tree of his choice and then to study the tree itself, to fix in his mind its most outstanding features, rather than read terse botanical descriptions. He then refers the amateur to the brief descriptions of species, given in simple language, in Chapter II, and the cultural hints given in Chapter III.

In the descriptive catalogue (Chapter II) two lists are given: List I of trees tried and found suitable, and List II of other trees deserving trial. Species have been arranged alphabetically by the scientific name, but common English and regional names have also been mentioned and an index of the latter given at the end of the Bulletin. The main features described for each species are (*i*) the derivation of the scientific and common name (to serve as an *aide memoire*), the habitat of the species, its distribution in India, its ornamental features, phenology, method of propagation, and finally the purpose for which the species is most suitable.

To enable the amateur to select species for any specific purpose classified lists have been given as under:

I—Species suited for large-tree avenues planted mainly for shade;

II—Species suited for medium- or small-sized tree avenues planted for shade and ornament, separately for—

(*i*) Shade trees;

(*ii*) Trees with showy flowers; and

(*iii*) Trees with ornamental foliage;

III—Species suited for planting in (*i*) groves for shade, and (*ii*) clumps for ornament;

IV—Species suited for planting singly for shade or ornament; and

V—Species with sweet-scented blossom.

Chapter III gives general cultural hints on propagation, planting, protection, pruning, etc. It has been emphasized that there is a limit to which written instructions can go, beyond which success depends on what Mr. Sagreiya calls the "green finger," namely, that magic touch which is acquired only after constant practice and an intelligent use of observations.

G. S. S.

THE BOOK OF INDIAN BIRDS

[*By Salim Ali. Bombay Natural History Society, 6 Apollo Street, Bombay. Price Rs.* 14.]

It is only a short time ago that we had occasion to review a book on Burmese birds in these pages and we had pleasure in recommending it to all bird-lovers.

The eagerly-awaited book by Salim Ali on Indian birds has at last appeared and we predict for it an even greater welcome than that which, I am sure, Smythies' book is deservedly enjoying.

Salim Ali's book is a limp covered volume of convenient size which can easily be slipped into the pocket and, therefore, can be a constant companion in field and forest. This naturally is a great advantage when the amateur sees a bird and wants to know all about it on the spot. It must be a very keen enquirer who notes down the description of the bird in order to look it up at home.

In the introductory remarks we are given a good deal of interesting matter about birds generally. This is followed by an illustrated key giving the technical terms applied to birds and demonstrating the change in bill and claw with habit.

A most useful section follows. This is entitled "how to recognise birds in the field." This key is an ingenious combination of colour, size and often another feature such as size of bill or length of tail. We venture to state that this will be a most popular part of the book and, combined with the coloured plates, should enable any common bird to be identified without difficulty.

The general part of the book is taken up with 171 plates representing 181 species. A word about the plates. For the most part these are adequate but in some cases we suspect that the artist was trying to reproduce the colours of the birds faithfully without

at the same time conveying the impression of a living bird. An example of this is the Black Partridge. We share the astonishment of the Brown Fish-Owl at the size of the shark he has caught (p. 227). Opposite each plate is a page of text dealing with size, field characters, distribution, habits and nesting. Here the reader is told all that he is likely to want to know about any species. Some of the author's word pictures describing various bird-calls and peculiarities of flight are delightful. One of the most interesting aspects of bird life is the courtship display of certain species. That of the Purple Moorhen (should it be Moorcock?), especially if his plumage remotely resembles that of the coloured plate, must be particularly devastating to any hens, susceptible or otherwise, in the neighbourhood. Before we condemn such behaviour as ludicrous, let us for a moment remember the prancings, posturings and curvettings of our own hobbledehoy age, with which we sought to impress the local maidens.

Other interesting and most useful sections are interspersed in the text, they are: some nests and nesting behaviour, bird migration, the usefulness of birds and bird watching. The black-and-white plates which illustrate these sections are superb.

This is a really good book and we advise all forest officers to procure a copy. Incidentally, while doing so, they might also consider becoming members of the Bombay Natural History Society. The latest list of members contains surprisingly few names of forest officers.

N. L. B.

EXTRACTS

FOREST RESEARCH AND WAR PROBLEMS

BY S. H. HOWARD,

Inspector-General of Forests.

But what, I am often asked, can forest research have to do with war?

At first, war work was spasmodic and demands were for actual supplies. With better organization of war supplies and more especially with the enormously increasing demands from the Middle East, the problems of war supply began to increase almost geometrically.

It was soon evident that the Forest Research Institute at Dehra Dun could not make its best contribution to the war effort by trying to turn itself into a supply unit. The machinery, the staff and the general organization is not what is necessary for an ordinary manufacturing plant. Everything at the Institute has been installed for research, and research, dealing with comparatively small quantities, can never be as economical as a factory. In order to turn the Institute into a supply unit, it would have been necessary to close down much of the research and to alter the whole organization. Even then it could not have been worked as economically as an ordinary factory and its total outturn must have been small.

It was becoming more and more evident that there was ample work on the purely research side and in training staff connected with military work (mostly Ordnance) to keep not only the whole existing staff of the Institute at work but to necessitate an expansion in certain sections. It was, therefore, decided that the Institute should not deal with actual supplies. It would confine itself to research work, trying to solve the various war problems that were put to it and, having solved the problem, would send the solution to those whom it concerned. It also advised, where necessary, how supplies should be obtained, but it did not undertake supplies itself except in experimental quantities for practical tests. At the same time it was decided that an important part of its war functions should be to instruct where possible those dealing with the war supply of forest products.

While a great deal of work has been connected with direct war supplies, there has also been a considerable amount of research for industry and trade to find Indian substitutes or supplies of articles, the import of which has been stopped as a result of war.

ALL BRANCHES ACTIVE

As supplies for war are almost entirely concerned with the utilization of produce—one might almost say with the waste of produce—it is perforce inevitable that war problems most often concern the Utilization Branch. But while that branch is inclined to overshadow the contribution of other branches, it is incorrect to imagine that other branches are not very directly concerned.

The Chemical Branch, for instance, is really as directly concerned with the utilization of produce as the Utilization Branch, though naturally its produce is what the forester classifies as "minor forest produce." It has been doing considerable work, and is likely to do more, on the supply of medicinal drugs like creosote B.P., guiacol, guiacol carbonate, oleum picis B.P., pix liquid B.P., all from chir tar oils; on Stockholm tar substitutes for ropes; on chir tar suitable for the work of the rubber trade. It has produced liquid rosin for bituminous emulsions, a vegetable tallow as a substitute for wax for coating matches and, a small but interesting item, a wood dust to fill dry-cell electric batteries, all of which formerly came from Germany.

The Entomological Branch has been doing direct war work on the identification and treatment of insects attacking timber and bamboos in the forests before the wood reaches the depots, and in the various war supply depots and arsenals throughout the country in close co-operation with the Timber Directorate and Ordnance, besides advice to the important plywood industry. It need hardly be emphasized how extremely important it is that army supplies, especially overseas supplies, should reach their destination sound and not rotten. A certificate that timber and packing material leaves the country free from borers is essential if attacks are to be controlled.

TIMBER DEVELOPMENT

Even the Timber Development Branch, which, in this Institute, is a small one-man show, has directly contributed designs for army huts which have simplified specifications, making the timber supply far easier.

Those branches, like the Botanical and Silvicultural branches, which are either apparently far removed from direct war work or which like the Silvicultural Branch, have perforce to work on a long-term policy because experiments may take many years to complete, are not so far removed from war work as one might imagine. Pyrethrum, used for insecticides, for which there is an immense demand in India, can probably be grown perfectly well in many parts of India. The Silvicultural Branch, which at this Institute

does the growing, has organized experiments through the silviculturists in the various provinces to experiment in growing pyrethrum. Though it is too early to prophesy, there is a possibility here of an industry which will long outlast the war.

Though there is no great difficulty about pyrethrum, there are other imporant drug-producing plants, for example, the artemisias, which produce santonin, where the variety which produces the drug may be, to the layman, remarkably like a variety which produces nothing. Here the Botanical Branch comes in. It is obviously important, and more especially important for war supplies, not to make a mistake in the species grown.

Correct botanical investigation is equally important for all identification of wood, because the Wood Technologist, who identifies wood and produces keys by which the less expert can also identify wood, needs the original botanical identification as the basis of his work. It is the botanist originally who identifies a tree as walnut, which is used for gun-stocks, and on his identification of the species the Wood Technologist builds a description of the wood itself so that in future the wood can be identified apart from the ordinary botanical characteristics. He is then able to say whether war suplies for gun-stocks said to be walnut are really walnut or not.

Even though the Botanical and Silvicultural branches are not as directly concerned with war work as some of the other branches, or at any rate are not spending so large a proportion of their time on direct war work, it has been decided that the activities of those branches should be continued during the war.

INSECT DAMAGE

The reason can be seen from the examples of the war work of both the Entomologist and the Wood Technologist. The advice and control of insect damage done by the Entomologist and directly concerned with the depots and arsenals directly supplying war material, is not the result of any research done since the war started but is based on the knowledge gained over 30 years of continuous previous research at this Institute. Equally the Wood Technologist, whose whole time at present is spent on identifying material sent in by various Army Departments or in teaching members of the Ordnance Inspectorate to identify timber supplied, is

not doing his work as a result of something started since war began, but, again, is applying knowledge gained over years of patient research—much of it at the end of a microscope.

Without the results obtained by those two branches in the past, and more especially the results of the Silvicultural work, it would not be possible for the immense timber supplies now being made by the various provinces in India to be made with such an exact knowledge of how, where and when to cut with the least damage to India's forest wealth. It is the Silvicultural Branch of the Forest Institute which produced the first Indian yield table in 1926, long before it was expected, and followed by tables for other species at regular intervals. These tables, giving as they do the diameter, height and, per acre, the number of stems, the yield, the number of trees to be thinned, etc. etc., at various ages, enable the forester to gauge the exact effect of the fellings he is now making for war supply.

REPLACING TREES

It is also the silviculturist's work here and in the provinces which teaches the forester how to replace the trees now being felled to supply India's war effort. Without timber the armies could not function. All foresters are silviculturists but the ordinary forester applies the art after the research is done.

While I have stressed the contribution of those branches of the Institute whose activities are not so obvious to the general public as those of the Utilization Branch, I do not intend to minimize the contribution from that branch. Quite obviously most of the problems set to the Institute must be directly connected with utilization. That branch has had an endless variety of problems and they have varied from whether a bamboo container holding one gallon of petrol can be dropped from an aeroplane flying at 500 feet so as to land safely at 90 miles an hour with or without a parachute, to making wooden trouser buttons for the Army or wooden corks for medicine bottles—neither as easy of solution as you might think, especially as the necks of Indian medicine bottles are not always round.

No section of this branch is spending less than 50 per cent. of its time on war work and the Wood Technology Section is doing

nothing else, having identified in the last year over 2,000 specimens for the Army and made 450 special reports, usually requiring careful microscopic analysis, besides instructions to sergeants from the Ordnance Inspectorate at Cawnpore.

Even the paper pulp section which, it might be thought, was far removed from war, is spending three-quarters of its time on war work. It has recently made packing cases for petrol tins and other ordnance stores, a corrugated kraft linen board box having been accepted. A trial order of 100,000 boxes of 3 cubic feet capacity has been given and arrangements are being made for their manufacture by an Indian firm. This follows the general policy of the Institute for war work; that is to say, the Institute does the research but the actual supply is then made by a factory. Once the manufacture of this type of box is assured, it is likely to increase considerably in India.

AIRCRAFT BAMBOO TESTS

There is no space to give all the problems which have come to the Utilization Branch, but they include aircraft bamboo tests for the Royal Aircraft Establishment, Farnborough, bamboo tent poles, rifle woods, suitable cheap Army boot boxes, petrol boxes, nailing qualities of woods, aircraft timber tests both for the Royal Air Force and the Civil Aviation authorities, fibre boxes for ordnance stores, identity discs, cork substitutes, timber for ammunition boxes, tent poles, tent pins, cheap preservatives, fuel oils, tooth-brushes, plywood plates, etc. etc.

And there is money in it. If the Institute can produce a cheaper wood suitable for ammunition boxes, as it hopes to, saving one rupee a box, that means 10 lakhs of rupees on a million boxes. With the present income-tax I am sure every tax-payer will appreciate that.

Months ago the seasoning Officer was deputed to the Ordnance Department to supervise the erection and improvement of seasoning kilns at the Gun Carriage and Rifle factories and is now deputed to the Timber Directorate, other members of the seasoning staff being also deputed to carry on the kiln work.

A number of men from the Ordnance Inspectorate have been trained in various branches of the work.

Forest research thus has its place in modern war. So long as forest products are needed by the soldier or by the civilian behind the lines who supplies the soldier, just so long is forest research a necessity. And just because so much of it yields results only after many years of patient work, so is it all the more necessary to keep working even in war. It takes anything from 50 to 150 years to produce mature timber even after research has told you how.—*The Statesman,* September 7, 1941.

INDIA'S MATERIAL RESOURCES WITH REFERENCE TO WAR REQUIREMENTS

By Sir David Burnett Meek, C.I.E., O.B.E.,

Director-General of Commercial Intelligence and Statistics for Government of India, 1926—1935: *Indian Trade Commissioner since* 1935.

The vast Government-owned forests of India, some 160,000 square miles in extent, representing some 15% of the total area of the country, yield annually, in addition to great quantities of timber and firewood, a mass of products known generally as "Minor Forest Products." They are minor only in the sense that the principal object of forestry is to grow timber, but in all other aspects such as revenue-earning capacity, extent and value as sources of raw materials for many industries, they are of first-class importance. Thus: "sabai" and other grasses and bamboos for paper making; oleo-resins for rosins and turpentine; cutch, barks and nuts for tanning materials and tanning extracts; gums and resins, principal amongst which are gum arabic, and its varieties, and shellac and lac, for use in textiles, varnishes, etc.; plants and fruits for use in medicine, such as ephedrine, santonin, chaul-moogra oil, and many others; extracts from plants and grasses to produce essential, medicinal, and perfumery oils such as "rosha" and lemon grass oils, sandlewood oil, and so forth; this epitomizes the list, but does not exhaust it.

Vast though the forests of India are, the demands of India's teeming population and rapidly expanding industries are such that there is no exportable surplus, present or prospective, of timber; in fact, many parts of India are in short supply and annual imports of timber, principally of coniferous types, are substantial. True, in time of war, overcutting the forests might be necessary, as a temporary measure, but only as a last resort. Mention, however, has to be

made of the small but valuable export trade of certain hardwoods from India to the United Kingdom, such as "padauk" and others, in considerable demand by architects and others seeking new decorative effects; India House, London, affords a fine example of what can be done with these highly decorative woods.

Consequently, the so-called "minor forest products" have to be singled out as the category of raw forest materials of importance to India and the Empire in wartime. Their importance to India is of a two-fold nature; firstly, to increase her own production of manufactured goods such as paper, rosin and turpentine in order to reduce imports and thus save vital shipping space and, secondly, to increase the output of raw materials such as tan-stuffs, gums and resins, the export of which is essential to expand and keep the Empire war effort at its maximum. Paper and wood pulp consumption in India is a very large item, imports immediately prior to the war being of the order of 175,000 tons annually, whilst manufacture in India, though expanding satisfactorily, only amounted to 50,000 tons. The most interesting feature here is the increasing use of bamboos in the Indian industry. India and Burma have large areas of bamboo forests and the crop is ready for use every three years; compare this with the forty years required to bring the coniferous pulp wood of Scandinavia or Canada to maturity and one realizes what a remarkable source of supply India possesses. A rapid expansion in bamboo utilisation would be a notable contribution by India to the Empire's war effort.

Another example is the rosin and turpentine industry. The tapping of the almost continuous belt of pine forest running roughly East and West in the Himalayan range has, in a quarter of a century, made India practically independent of American sources of supply, whilst an export trade is being steadily built up. India is the only producer of rosin and turpentine in the Empire, though Australia and British Honduras may soon make a start.

With supplies of tan-stuffs from foreign countries to the United Kingdom to a large extent reduced, the mother country and other parts of the Empire will have to rely more and more on the resources* of India, Australia and South Africa in such materials. India's

* For further details see "An Index of the Minor Forest Products of the British Empire," Imperial Economic Committee, London, 1936.

contribution is already notable. In 1938-39 India's export of myrobalans, nuts and tanning extract was a little over 62,500, of which the United Kingdom took nearly half. In gums and resins (other than rosin) India can also assist to maintain the supply to the Empire of those essential commodities so much used in the textile and paint and varnish industries. The most important commodity is shellac (and lac products in general) of which India exports over 30,000 tons a year, America and the British Empire being the principal consumers. Much research work has been done on lac since 1925 and consequently the position of this plastic and varnish material is today strong and healthy, with no prospect of going the way of the Indian natural indigo industry, which was killed by a synthetic rival. Shellac owes much to the policy of intensive chemical research, hand-in-hand with industrial application, adopted by the Government of India. India, the land of drugs and spices, is playing an important rôle in producing a series of medicinal products of great value to the Empire; to wit, quinine (plantation-grown and thus perhaps hardly classifiable as a forest product) and others already mentioned in this article. The theme could be developed but enough has been said and sufficient examples cited to indicate the rôle which the raw and manufactured products of India's great forests are playing in sustaining and developing her war effort.

Forest research since 1908 has been largely instrumental in these developments, but much has still to be done to bring out the full earning capacity of the Indian forest estate, by the Forest Research Institute, Dehra Dun, the largest institute of its kind in the world. All honour to those who, over seventy years ago, realised the value of forests and forestry to India and the important part scientific forestry management can and does play in the industrial development of a country. Limitations of space have made it possible to give only a very brief indication of some aspects of India's war potential. The country is really a sub-continent with immense resources which are gradually being developed. It may be expected that this development will be greatly accelerated by the recent establishment of the Eastern Group Supply Council, whose records will, in due course, give fuller details of the capacity and actual achievements of India. —*Chemistry and Industry*, Vol. 60, No. 17, dated Saturday, April 26, 1941.

INDIAN FORESTER

DECEMBER, 1941

OBSERVATIONS ON THE ECOLOGY OF *TECTONA GRANDIS* IN THE CENTRAL PROVINCES

BY C. E. HEWETSON, I.F.S.

Summary.—The main points of the Ecology of teak in the Central Provinces are discussed and four suggestions made:

(*i*) The soil derived from Trap rock is especially suitable to teak and that this is due to these soils being more moisture-retentive than those derived from sandstone or crystalline rocks.

(*ii*) Fire protection is normally helpful to teak in this area.

(*iii*) The other species present in the forest play a large part in the establishment of teak seedlings.

(*iv*) The combination of teak and bamboo may be a true climatic climax, but the loose use of the word "teak forest" to describe a formation in which teak trees form a varying proportion of the crop and where it is one of a number of species is dangerous to clear thinking. For the present it is better to regard forest in which teak forms a higher proportion of the crop than usual as a seral type.

Note.—Our present knowledge of the types of forest vegetation occurring in the Central Provinces is summarised in Champion's *Preliminary Surevy of the Forest Types of India and Burma*, pages 129—142. This account should be consulted for statistics of temperature and rainfall and for the scheme of classification of forest types. Lists of the species found in the forest are also given. The term "Climatic Climax" is used according to Clement's definition.

In Champion's classification Teak Forest is shewn as a climatic climax. For the silviculture of our forests it is important to discuss to what extent this is true. If it is a climatic climax, we can assume that our present teak forests are likely to remain so indefinitely; if it is only a seral type, we must work continuously on the environment so as to retain the forest in its present condition.

Teak does not grow gregariously to the extent of *sal* or pine or spruce. Champion (page 137), speaking of teak forest in the dry deciduous zone, says: "The presence or absence of a single species is admittedly a poor basis for differentiation, though an aggressive dominant such as *Shorea robusta* may reasonably be used in this way. The absence of teak in dry forests is often difficult to account for, but in many places intensification of the dryness of the locality,

physically or physiologically, is definitely the cause." The forest to which we apply the term "teak forest" is not to be pictured as a uniform type of association covering considerable areas. In the Central Provinces the composition of the crop is varying from place to place, and over short distances. The proportion of teak in the crop is also changing rapidly. *It is better in the first place to* consider teak as one of a large number of species growing in the Mixed Deciduous Forest, and forming a varying percentage of the crop.

The object of this paper is to discuss the autecology of the teak tree in the Central Provinces, and to present a picture of the teak tree in relation to its environment. The question whether in any circumstances teak is capable of maintaining itself as the dominant species and whether we are justified in considering "teak forest" as a climatic climax is briefly dealt with.

Teak and the Soil.—To discuss the relationship in the absence of any research on forest soils in India is dangerous; but, when research lags behind, the field worker must be allowed latitude to make guesses based on his own observations. It has been obvious for many years that the distribution of teak is to a large extent controlled by the soil and the underlying rock. I propose to take two examples:

(*i*) The general distribution of teak in the Province, and

(*ii*) Local abrupt variations occurring in the Betul and Hoshangabad Districts.

General Distribution.—The teak tree occurs commonly in the Khandwa, Hoshangabad, Betul, Amraoti and Yeotmal Districts. It occurs locally in Chanda, Bhandara and Raipur in the south of the Province and in Seoni, the south of Jubbulpore and Saugor Districts in the north, The western districts are covered largely by the Deccan Trap; and in the other districts the teak is found on the outcrops of Deccan Trap. The Chanda forests are an exception, but, generally speaking, teak is common where trap rock is common; and decreases proportionately with the amount of surface covered by trap.

Local Variations.—This can be studied in the Betul and Hoshangabad Districts as the changes in rock are frequent and abrupt. One good example is provided in the Tapti Valley in

Betul. The rocks in the valley are chiefly trap; and the first impression is that the trap is continuous. In fact it was not until I started stock-mapping that I saw how rapidly the type of forest was altering; and, looking from the forest to the soil, I noticed that the underlying rock was varying. Trap rock is most common, but sandstone and conglomerate are also exposed. On the soils overlying the trap, the teak may form as high as 75 per cent. of the growing stock; though this is partly due to improvement fellings carried out by the Forest Department. On the soils over the sandstone the percentage of teak is low, and very often teak is absent. (See Fig. I Plate 22.)

In the north of Betul District and the south of Hoshangabad District the common rock is sandstone. There are several different formations, but on all of them the forest is of low height growth, and the less valuable species are predominant. At intervals there are outcrops of basaltic rock (presumably of the same age as the Deccan trap). These outcrops usually form low hills running east and west. Wherever they occur, at least I have not found any exceptions, the teak tree also occurs. Usually the teak grows up on the edge of the outcrop beyond which there are no teak trees.

The example *par excellence* are the famous Bori teak forests*. I have only a very cursory acquaintance with this area but the main details are clear. The prevailing rock is sandstone and the northern boundary is formed by steep cliffs of sandstone whose summits are weathered into a fantastic skyline of abrupt peaks. South from this wall the country is broken up by low hills, irregularly placed, but tending to form ridges running east and west. As one ascends a hill, the forest is of low height growth, about 50 feet, and the trees are small. Teak trees are rare and of small size. After rising 200 or 300 feet, there is an abrupt change. The percentage of teak rises to 75 per cent. or more, and the trees are 70 feet to 90 feet high and up to six or seven feet in girth. The rock has also changed to trap. Whether this trap is a cap which has been left after the denudation of the areas intervening, or whether it is an intrusion into the sandstone hills is not of much importance. Of course in

* Bori Reserve, 1859—1940. T. McDonald, I.F.S., *Indian Forester*, September, 1940.

places in the valleys fine growth is found but this is on recent alluvium formed from the trap and sandstone hills.

A third example is less certain but in the north-west of Betul district the boundary is formed by the Moran river which flows through a gorge about 400 feet deep. The walls are formed by sandstone rocks on which a few teak trees grow. At the foot of the gorge along the river in discontinuous patches magnificent teak trees grow. These patches are the low-lying areas where soil has been deposited by the river. The river in its upper reaches flows over trap rock and I suggest that it has brought down silt derived from the trap rock and deposited it in these flat areas along the *nala* in the gorge.

The deduction I make is that the soil derived from basaltic rock is necessary to teak trees. The explanation of the dependence must await detailed soil analysis, but I will venture some observations. In the first place, there is no obvious chemical difference. The teak-bearing soils and the soils without teak have approximately the same PH values. A consideration of the characters of the teak plant may help to explain the problem. The times of leaf-fall and the appearance of the new leaves; and the root system of teak are the points to which I wish to draw attention.

Life Form of Teak considered in relation to the Soil.—The time of leaf-fall varies from place to place. On slopes with southern aspect the leaves fall earlier than on northern slopes; in Berar where the rainfall is under 30 inches the teak may be leafless in February; in the Bori forests green leaves may be found in April. The appearance of the new flush of leaves depends on the monsoon. In 1939 the rains did not break in some areas until July 9th and the teak was still leafless. In 1933 heavy showers were received in April and May and the teak were all in leaf by May 15th. The leaf-fall and the bursting of the buds are related to the moisture in the soil. By reason of this character teak can survive in a soil which dries out completely in the hot weather. Other typical species of these forests come into leaf by the same date every year; for instance *Terminalia tomentosa* in May, or *Schleicheria oleosa* in March. As these trees are in full leaf in the hot weather they must tap water supplies at a considerable distance from the surface.

In the Central Provinces the teak is a shallow rooting tree; by this I mean that the roots are spread in the soil and the subsoil. The roots do not penetrate to a depth of more than four or five feet. Teak is the tree most frequently thrown by wind and the root system then exposed shews no strong tap root. For supplies of water the teak is dependent on the amount held in these layers. Once in leaf the teak trees become vulnerable to drought or drying out of the surface layers.

The first character of a variable dormant period enables the teak plant to survive in a soil that dries out completely; the second demands that in the growing season the soil shall be moisture-retentive. These contrasted behaviours are combined in the soils derived from trap-rock. Soils derived from crystalline rocks are more porous and it is on these soils that teak is least common. Soils derived from sandstone are intermediate. The necessity for moisture-retention is probably explained by the distribution of the rain in the monsoon. In this province a break for 15 days to three weeks is common, and in this period porous soils may dry out. The first character is advantageous to teak in the less fertile soils over trap-rock. The subsoil water is a long way from the surface and frequently the underlying rock is very hard and impenetrable to tree roots. Trees which come into leaf in the hot weather are at a disadvantage and it is on these soils that teak forms a large proportion of the crop.

In the *Silviculture of Indian Trees* it is recorded that in the Peninsula teak has usually suffered more severely than any other species from drought, trees as well as coppice-shoots being killed or hopelessly injured in large quantities. It is not recorded whether the mortality was more severe on the soils derived from crystalline and sandstone rocks than on the soils derived from trap. These critical years play a large part in the distribution of species. The last really severe droughts in the Peninsula were 40 years ago and, in the meantime, teak may have invaded soils on which it will be unable to survive when the next drought comes.

I do not want to set up a conception of "teak soils." In the Central Provinces the distribution of plants is controlled by the balance of many factors and certainly soil never exerts such a large

influence that other factors can be neglected. A soil originally light and porous may become water-retentive by the addition of humus; a soil derived from trap may be converted to laterite and become highly unfavourable to teak. What we can say is that, from a consideration of the life form, the moisture-retentiveness of the soil during the growing season is an important factor in the distribution of teak and that the soils derived from trap-rock are naturally the most water-holding.

Effect of Fire on Teak.—This is a complex interaction. Obviously hot fires have a more far-reaching effect on the vegetation than mild ones. At the outset it may be assumed that the dry deciduous forests have been subject to fires for thousands of years. The introduction of fire protection has changed the conditions of life radically. In unprotected forest the effect of fires on teak can be seen. In the majority of the reserved forests fire protection has been effective for many years, and in addition the damaged trees have been cut out in periodic fellings. I was fortunate this year to find a remote area which had never been "improved" and where even the climbers had never been cut. It is illustrated in Fig. II of Plate 22 and in Plate 23. Ninety per cent. of the teak trees were badly damaged by fire and were very unsound at the base. It is clear that the length of life of of the teak trees in these unprotected forests is determined by fire. Eventually the base of the tree is so reduced that the tree falls when the next storm blows. In such fires the teak seedlings also suffer some damage, but the teak seedling is less easily killed than those of other species (*vide* Fig. II, Plate 22).

There is a difference between the sensitiveness of the teak stem and the root. The stem is sensitive owing to the thin bark of teak, but the root-stock is practically indestructible—a character it shares with its relative *Lantana*. This can be well seen on fire lines which are cut and burnt annually. There are lines which have been cut and cleared annually for 30 or 40 years, on which a dense crop of teak comes up each rains. The hardiness of the root-stock enables teak to survive when areas are cleared for shifting cultivation, and also enables teak to survive in over-grazed village areas long after all the other species of these parts have disappeared. Teak and *Butea frondosa* are the last remnants of the forest.

Fig. I

Typical middle-aged crop of Teak and *Ougeinia dalbergioides* on trap but with no bamboos. Thinning has recently been carried out.

Photo taken in March.

Fig. II

In Government Reserved forest but in a place where protection has not been successful, shewing how the boles of teak are gradually burnt out. The tree was still alive.

Fig. I

Shewing how the virgin forest of the Central Provinces may have appeared. The teak tree was 7 feet 9 inches at breast height. Note the burnt-out snag in the foreground.

Fig. II

Taken in Betul Forest Division and in the same area as Fig. I of the plate and Fig. II of plate 22. No work had ever been done and the forest is on the top of a remote hill. It was never visited by the local villagers. The points to notice are the teak tree severely damaged by fire, the large climbers (*Butea superba*), the bamboos (*Dendrocalamus strictus*) and the absence of other trees shewing the low density of the forest.

Photo taken in December.

Another effect of fire is seen in regeneration areas where after felling there is frequently a large amount of slash left in the coupe. Such areas are generally closed to grazing and the grass after one or two years is very dense. If a fire breaks out in such an area the heat of the fire is intense and a large number of tree species are killed outright. After such a fire the proportion of teak in the forest relative to other species is increased.

In forest fires it is the ground vegetation which is damaged to the greatest extent. Successful fire protection results in a gradual increase in the denseness of the understorey. The discussion of the interaction of other plants on teak is discussed later.

In general, then, fire protection is very favourable to the teak, though it may not result in an increase in the proportion of teak in the forest relative to other species. In the case of teak fire protection is favourable to teak in the tree; in the case of most of the other species the benefit is more for the survival of the seedlings.

Influence of Man on Teak.—The action of man has not been constant. By clearing forest for cultivation, man tends to destroy other species more rapidly than teak; and on soils favourable to teak the proportion of teak tends to increase should the area be abandoned after a few years. In some places the local rules or laws by terming teak a "Royal" tree may protect it and give it an advantage over its rivals.

On the other hand the local inhabitants may seek out the teak trees when the value is high enough to make it worth-while to export. This tendency was very strong soon after the British had established control of Central India. The demand for teak was insistent and even the remotest forests were being exploited. In fact it was the prospect of the rapid exhaustion of supplies of teak that was responsible for the organisation of the Forest Department and the reservation of Government Reserves.

Since the formation of the Reserves the conscious effort of the forest officer has been to increase the proportion of teak in the forest. Thus on the whole the actions of man in the last century have been favourable to teak.

Climatic Factors.—On the whole these can be neglected as far as the Central Provinces are concerned as there is not sufficient

variation within the area. There are one or two points worth mentioning.

Rainfall.—This effects the vigour of the tree rather than the distribution. The optimum rainfall for the best development of teak is probably between 80 and 120 inches annually, but in Berar it has to manage with 30 inches or less falling in three months which means a very short growing season. Presumably this is close to the minimum rainfall, and in these parts the teak is a very small tree not the least resembling the forest giant of the picture books.

Frost.—Teak is sensitive to frost but can survive considerable damage owing to its powers of making new growth from the base of the dead wood. In bad frost localities tall trees may be found with a pyramidal form. Such trees are cut back every two or three years but still survive. Except perhaps in the north of the province it is doubtful whether the distribution of teak is controlled by frost.

Altitude.—I include this here. It is apparently true to say that teak does not grow naturally over about 3,000 feet in the Central Provinces. It is absent from the higher plateaus and is generally less vigorous from about 2,500 feet. No explanation of this has been put forward. It is not due to frost as the plateaus enjoy a more equable climate than the valleys below. The effect of altitude on temperature is overcome by the convection currents whereby the cold air sinks into the valleys, and the upper levels are enveloped by the warm air displaced by the down-flowing cold air. It may be due in some places to the high winds which sweep these plateaus.

Interaction of other Plants with Teak.—It is a commonplace among forest officers in the Central Provinces that in many places the proportion of teak in the crop is gradually increasing. Forests with few teak trees contain many seedlings. The succession may be accelerated sporadically by improvement fellings, in which other species standing over teak regeneration are felled in groups; or intensively as when an area is clear-felled. After clear-felling the teak regeneration takes advantage of the full overhead light and grows more vigorously than the majority of other species. Also 100 per cent. of the teak stumps give coppice shoots, while there is a certain mortality of other species. The new crop may contain 75 per cent. of teak against 5 per cent. in the old overwood. The inter-

esting point, however, is to explain why there was such a large proportion of teak regeneration. The mixed deciduous forest, in which teak was one of a number of species, has persisted for thousands of years. The sudden conversion to a forest with a high percentage of teak is important and deserves investigation. Unfortunately the study of the natural regeneration of teak has been neglected. The ease with which plantations can be made has concentrated attention on artificial regeneration, and there is no body of knowledge comparable with the work on the natural regeneration of *sal*.

In the first place I would suggest that natural regeneration of teak is more common on the intermediate soils where the height growth is between 50 feet and 65 feet. On more fertile soils regeneration of teak is less frequent; while on the best soils regeneration of teak is often entirely absent. The reasons for this are unknown.

The appearance of dense regeneration of teak is common on the medium quality soils and in those forests where there is a fairly dense understorey of the bamboo (*Dendrocalamus strictus*). I put forward the following highly speculative account to explain the progression of the normal mixed deciduous forest to a condition in which teak becomes the dominant species. As mentioned above the chief result of successful fire protection is the survival of seedlings of trees and shrubs. Most of the tree seedlings remain a long time in the seedlings stage while their roots are growing down to the permanent water level. If the forest is not burnt a few seedlings become established and as they grow up they close the canopy gradually and kill out the grass. However, sufficient light penetrates the overhead canopy to permit the growth of a dense second storey. The composition of this second storey varies from place to place, but I consider it to be a regular feature of all the deciduous forests of this region. One of the commonest plants is the bamboo. Other examples are the imported *Lantana camara* which is a pest in the Melghat forests. Other plants locally common are *Nyctanthes arbortristis, Petalidium Barlerioides* and on moister soils *Colebrookia oppositifolia, Pogostemon plectranthioides* and *Milletia auriculata*. The climber *Bauhinia vahlii* is gregarious on certain soils, particularly those derived from crystalline rocks. An interesting

practical exploitation of this tendency is the establishment of a coffee plantation under the shade of the natural forest at high altitudes in the Central Provinces.

The forest in which the understorey is made up of bamboo is of greatest importance to teak. Fire protection is very favourable to the growth of bamboo owing to the culms dying and remaining in the clump. In a severe fire the dry culms are set alight and the clump is severely damaged. When fire protection is successful the bamboos rapidly occupy the understorey. The density of the bamboo varies with the soil. On moderately fertile soil the bamboos are sufficiently dense to prevent the growth of grass and most other species. On very moist soils the bamboo may become so dense that no other species can grow. This second condition can be seen in the Bori Forests of Hoshangabad and in the teak areas of Chanda District.

Where the bamboo becomes moderately dense the regeneration of teak is most common. The shade cast by the bamboo is too dense to allow grass and weeds. We know from artificial regeneration that the teak seedling cannot survive against the competition of the grass roots. It is therefore no surprise that conditions are favourable under a moderate bamboo understorey. In addition the root system of the clump is entirely vertical. Thus the bamboo does not compete with the teak seedling. In comparison with the other seedlings teak can surprisingly stand a great deal of shade. Teak seedlings will persist under shade so dense that no other species can survive. It may be noticed that the leaves of such seedlings are often large and it may be that the expanse of chlorophyll in relation to the size of the plant is some hundred times as great as that of seedlings of the other usual species. An interesting but unexplored point is the fact that if the shade is removed over a seedling which has been suppressed, it will make very slow growth. If, however, the suppressed stem is cut at ground level the new shoot will develop vigorously in full overhead light.

The foregoing is a possible explanation of the observed succession to a forest with a higher percentage of teak. The old equilibrium has been disturbed by fire protection and the appearance of a denser second storey has made conditions more suitable for the

establishment of teak seedlings than of the seedlings of any other species. It will be seen from this that one of the conditions for the natural regeneration of teak is that in some way the ground should be kept free of plants likely to compete with the young seedlings. In the forest this is done most effectively by an understorey of bamboo. I would suggest that there is a natural affinity of teak and bamboo and that we may be justified in talking of "teak and bamboo" as a climatic climax.

The condition found in these teak and bamboo forests is that the trees making up the overwood are widely spaced and the smaller size classes are deficient. The understorey is fully occupied by bamboo. A few teak seedlings are found. This condition persists until the bamboos flower, seed and die. In the Central Provinces the bamboos are not dramatically gregarious and the flowering is usually spread over three or four years. The ground is then covered with a dense thicket of bamboo seedlings, but these grow comparatively slowly and require 10 to 15 years to develop into the typical clumps. During this period the seedlings of any tree species have their chance to grow up and elevate their crowns above the bamboos. As teak is one of the species best adapted to survive under the shade of the bamboo, naturally there will tend to be a higher percentage of teak in the crop after each successive generation of bamboo. The seedling of the bamboo is a climacteric in the history of the forest in another way. After the bamboo clumps have died and fallen over there is a great accumulation of inflammable material on the ground. If a fire passes through the forest at this time the heat of the fire is exceptional and the major amount of the fire damage seen in the forest may be done in these fires. The mortality of the tender species must be very high and may largely account for the absence of certain species from the locality.

I was fortunate this year in finding an example of this type of forest which has remained untouched by the well-intentioned forest officer, and as nearly as possible is virgin forest. It lies a few miles south of the Bori reserve and is of the same type and on the same soil. Fig. II, Plate 23, gives an impression of the association. As far as one can condense the main characters of the vegetation in one plate this photo is satisfactory. The points I wish to draw

attention to are, the burnt out teak tree, the climbers (*Bauhinia superba*), the dense bamboos and the wide spacing of the trees. This photo has the merit that no preliminary fellings were made to make the picture. Fig. I, Plate 23 is perhaps a better photo but the bamboos were cut so as to expose the bole of the tree, which was the biggest recorded in the division, seven feet nine inches girth. The burnt-out stump of the teak tree in the foreground of the plate is typical of the forest. The close-up of the tree with the Korku looking through is also from this forest. While on this subject I have included a picture of an old teak tree in a forest in which fire protection has been successful; it is rare to find such trees in our forests now as they have been eliminated in improvement fellings, but this tree does shew how the life of teak trees can be extended by fire protection (*vide* Fig. I, Plate 22; and Plate 23).

In the Bori Reserve we can see the same type after 70 or 80 years of fire protection and intensive tending by forest officers. It is also one of the forests for which we have the longest record as it was inspected by Sir William Schlich in the 1870's and again in 1881. He then described it as "teak and bamboo" forest. At that date the forest had not been tended by forest officers and the condition must have been natural. The forest also contained big trees so that shifting cultivation must have been rare. Since then the forests have been worked over, and the proportion of teak increased by tending operations. The bamboos still remain and teak seedlings are still the most common. This is fair proof that this is a permanent type of vegetation.

On the other hand there is no evidence that a forest with no bamboo understorey will be able to maintain a high percentage of teak. The canopy formed by a pure stand of teak is generally light and in the absence of bamboo the ground is covered by grass. Such conditions are known to be unfavourable to teak seedlings and there may be a gradual deterioration of the soil under such conditions. As a considerable area of plantations is being made in the province and, under the normal working plans, considerable areas are being converted to forest with a high percentage of teak, it is of great importance to the silviculture of our forests to find out whether we should underplant the teak with bamboo in those areas

where bamboos are absent; or take other measures to prevent a regress of the site to a drier type.

To complete the discussion I should point out that in the moister forests with perpetual fire protection the succession may move towards an evergreen type of association. It is probably rare in the Central Provinces but a tendency to a moister type can be seen in the Bori forests. In the *Indian Forester,* of August, 1940, I have described the type of forest found at the higher elevations in the Central Provinces and suggested that this approximates to an evergreen forest. The common species are *Eugenia cunea, Mallotus phillipinensis* and *Colebrookia oppositifolia.* These species may also be found in the Bori forests at 1,400 feet: they are also the species which are found in the moist *sal* forests in the United Provinces and Assam. These species seem to represent the borderline species between the dry deciduous and the semi-evergreen.

To summarise this section I would stress the profound effect of fire protection and the mutual interaction of the vegetation and the soil to produce a gradual succession of the forest from a drier to a moister type. In this succession the conditions at first are more favourable to teak but with the gradual change of the site the vegetation may pass to the semi-evergreen which is unsuitable to teak. We thus see that it is possible that teak can only dominate the vegetation in a comparatively narrow range of conditions; or from the point of view of the succession of vegetation during a comparatively short period.

LAND OF HOPELESS GLORY—II

By E. C. Bor.

When we arrived in Kyelang (Fig. I, Plate 24), we went first of all to the Rest House which lies in a quiet spot among the fields on the further side of the village. After the long and dusty march from Ghondla you curse the people who set the Rest House so far beyond the village. But if you ever have to live in a Lahouli village you realise that no Rest House, worthy of the name, could be set too far away.

For those two months that we planned to spend there our idea was to rent a house that had been built by a former doctor. He had built it for his Lahouli wife and then gone away and married another wife who refused to live in Lahoul. So there the doctor's house stands to this day, the most conspicuous building in Kyelang.

Because of its big glassed-in veranda which, from afar off, may be seen winking and flashing in the sunlight, we called it the "Crystal Palace" and on the evening of our arrival in Kyelang we walked down from the Rest House to take a look at the "Crystal Palace."

It is difficult now to understand *why* we ever expected to find the place in any way cleaned up in expectation of our arrival. It was not as though we had forgotten that Lahoul is almost on the borders of Tibet and that the Lahouli is almost a Tibetan and that he who looks for cleanliness in a Tibetan is a fool. But, after all, the "Crystal Palace" had been a doctor's house and I think therefore we were to be pitied, rather than mocked, when we expected that some notions of hygiene might have percolated through to the doctor's Lahouli wife who was to be our landlady. We were wrong. Cleanliness is remote from godliness in Lahoul and the doctor's wife (no doubt a godly woman) maintained the "Crystal Palace" in a state of greasy filth that competed easily with any of the smoke-grimed, grease-smeared, dirt-choked houses of the village. It was indescribably filthy.

We came away and arranged for a strong man from the village to spend the next day purifying the house. We knew that under our *chaprassie's* care the strong man would be able to cope with some of the dirt for we had already seen what the *chaprassie* was capable of when he got busy with a bucket of water and a tin of phenyle. The next evening we returned to see how the work had gone on. Long before we reached the rocky path that led up to the "Crystal Palace" we could sniff the fragrance of phenyle in the air and as we climbed the steep wooden stairs on to the veranda we met the last trickles of disinfectant sadly draining away from the flooded upper floors.

To reach the veranda you had to push your way through a trap-door at the top of the stairs and as we rose through the opening we

Fig. I

Kyelang

Fig. II

View From the Crystal Palace

Fig. III

View down the Bhaga Valley

Fig. IV

Eremurus Growing on the Hills

saw in front of us a bedroom door wide open. In the bedroom stood a rather dreadful bed and on the bed—or all that was visible of it—was a pair of mud-caked feet. Only last night we had been shuddering at the discovery of a splash of blood on the off-white door of that very room—and now we shuddered again, for it seemed that here, before our eyes—unearthed perhaps from under layers of grime—lay THE BODY—the explanation of those bloodstains. Murder is fairly common in Lahoul; but at that moment The Body came to life and showed itself to be the villager exhausted by his first (and probably last) experience of cleaning a house.

We banished the bed to an outhouse and, having looked round the place, decided that—although still incurably dirty—the house was habitable. Next day we moved from the Rest House to the "Crystal Palace", and thenceforward our house-cleaning was performed by a child who twice daily raised choking clouds of dust by means of a lammergeier's wing which was his conception of a sweeper's broom.

At no time during our life in the "Crystal Palace" were we able to get the veranda windows cleaned. There were hundreds of them all round three sides of the house and I don't suppose they had ever been cleaned since the place was built. It seemed hardly fair to expect a Lahouli to see any reason in wanting clean windows, so we left them as they were. It was just as well probably, for I think it was only their accumulated dirt that kept them in place at all. Every time the wind blew (which it did most afternoons, coming roaring down from the glacier) another piece of crystal was blown out of the windows. By the end of our two months there, if the garden hadn't been choked with weeds it would have been ablaze with bits of broken window.

Although it was difficult to see much through the grimed verandah windows, the position of the "Crystal Palace"—on a hill immediately above the village—gave us a commanding view of Life in Kyelang (Fig. II, Plate 24). Our general impression, after one week's residence, was of a noisy, dusty, smelly and filthy collection of flat-roofed houses, loud and lousy with villagers, yapping dogs, braying donkeys, shouting children and raucous-voiced fowls which produced no eggs. Two months' stay in the place did not modify this impression.

All that we saw, read and heard of the Lahoulis confirmed our view that they are not prepossessing. They are suspicious of all new-comers and if they decide to rid themselves of any intruder or innovation they band together and achieve their aim by force of boycott and sabotage. Consequently, a number of unsavoury customs—amongst others, that of polyandry—flourish in Lahoul.

The fairly recent discovery of Khut growing as a source of wealth has spoiled the Lahouli (particularly the men) of that frank friendliness usually found among hill people. All over Lahoul, especially in the Chamba valley, fortunes have been made from Khut and now the whole country is over-planted with that pungent-smelling plant and already a slump is beginning which, in time, will bring poverty and probably famine to Lahoul. Every available field is planted up with Khut and only an odd corner here and there is reserved for the growing of food crops.

Now that the Lahouli has money to spend, he spends it on "foreign" foods from Kulu and on tinned things and cheap Japanese rubbish and finery.

We noticed that the women were far pleasanter and more efficient than the men. The women do all the work of the house and —since the coming of Khut—nearly all the work of the fields. The men just lounge about the village or amble along the roads driving their mule-trains lazily over the passes, and laze and gossip over their mugs of "Lugri," a fiery drink distilled from barley.

No doubt the enforced idleness during the winter months helps to demoralise the men. In those days when the country is completely buried under snow there is nothing for the men to do except laze indoors and drink "Lugri."

From the very first we liked the women better. They always had a cheery word of greeting for you and they worked as though they enjoyed it—and sang while they worked. When they weren't using their hands for anything else they never stopped knitting. We often saw them carrying a fifty-pound load on their backs (sometimes with a baby slung on top of the load) knitting hard as they moved along the road.

Entering Kyelang from the Ghondla side you might think you were coming to a centre of civilisation. On the day we arrived there

we passed in succession—the Court House (indefinitely closed), the School (closed), the Moravian Mission (closed down), the Post Office (closed for the day) and three shops all closed until further notice. Outside the Post Office we saw a notice asking you to buy War Savings, and another that bade you save electricity.

The postmaster afterwards became one of our good friends. He was a bleary-eyed, fat old fellow with a voice like an indignant hornbill and he had been postmaster in Kyelang for nearly forty years. His name was Tuk-tuk, which means "The Slayer of Dragons."

We had not been long in Kyelang before we noticed that the business of field irrigation forms not only one of the most urgent of daily duties but also provides the Daily Laugh of Lahoul. This work of irrigation was introduced more than seventy years ago by the Moravian Mission who showed the people how to bring conduits from the glaciers to feed the barren slopes of the waterless mountains. By means of these channels the fields and meadows are flooded and good crops obtained.

As a rule the children seemed to be put in charge of the work of flowing the water into the various channels. As the work involved unlimited mud and unlimited opportunities for splashing and puddling and tumbling into streams, it was just sheer ecstasy for the children who allowed the water to pour through stone walls carrying away tons of precious soil which a thrifty people would have treasured and planted up. The Daily Joke in Lahoul is The Collapsing Wall. We used to hear an ominous rumbling that sent us hurrying out hoping to see an avalanche come roaring down from one of the glaciers. We saw the avalanche all right, but it consisted of a tumbling mass of boulders and mud being carried away from the wall of a near-by field, followed by peals of merriment from the villagers. The wall would be built up again and next day the same thing would happen somewhere else. We found it definitely dangerous to go walking anywhere near a wall while irrigation was going on. Presumably, if we had been struck down by any of the collapsing walls it would have added piquancy to the richness of the joke.

One evening we had just hurried past one of these danger zones when we saw that the channel of water was gently seeping under the tent of a family of nomads encamped in a field. Most of the family appeared to be busy outside the tent so we drew their attention to the creeping flood. At once they all yelled with delight and dashed to the tent whence emerged about eight or nine sleepers (at least they'd been sleeping up to that moment) all rather wet, all staggering about, slapping each other and shouting the joke from man to man.

This sort of thing was all part of the improvidence of the Lahoulis. There is a serious scarcity of wood, water and arable land in their country, yet they daily allow tons of plantable land to be swept away by landslides due to their careless methods of irrigation. They take little or no pains to plant or preserve the juniper trees that form their chief source of fuel and they leave unwatered tracts of dessicated soil which could easily be irrigated to form good fields for crops.

One thing we noticed and puzzled over there was the presence in large quantities of straw shoes scattered about the fields and paths. We had seen the women making those straw shoes which are almost universally worn in Kulu and Lahoul and we saw that a certain amount of time and trouble goes to the making of them. Yet, everywhere throughout the land we saw good straw shoes abandoned by their owners. At what precise stage of its life does one abandon a straw shoe? We were never able to discover.

Another thing that puzzled us was this—why don't Lahouli babies fall off the roofs of the houses? From the tenderest age Lahouli infants crawl and play and skirmish on the flat roofs of the mud houses. The houses are all two-storeyed, sometimes three, and the roofs have not a vestige of a parapet to prevent babies from falling off. Yet we never saw one fall.

While we were there we heard that one child had met its end in that way but that works out at only six per annum and by all the laws of gravity they ought to be falling off at the rate of at least six a day.

Much of the Lahouli carelessness is perhaps due to the people's blind reliance on the lamas to take care of all spiritual needs (what

Lahoul

time they—the lamas—grab all they can seize of the people's physical needs). The monasteries rule Lahoul and there are plenty of them perched on the sides of the mountains all round Kyelang. We used to hear them from time to time "doing their stuff" in the huge monastery that faced the "Crystal Palace" just across the valley. From the long curved horns would come an occasional howling groan or a deep uncertain growl; then a nun or somebody would give a wallop to a cymbal and we guessed there was no need to worry any more. Things were happening up there at the monastery. Kyelang was getting its money's worth of mummery and magic.

In this country of Lahoul, all life depends upon the glaciers—for they alone are the source of the country's water supply (Plate 25.)

The Bhaga river, thundering down in the bottom of the valley (Fig. III, Plate 24), has carved its bed too deep to be of any use for anything save the disposal of dead bodies. Owing to the scanty snowfall of the last three years, one village—the former capital of Lahoul—is now in desperate straits for water. There are no big glaciers near enough to supply a constant channel, and—until recently—the village has had to depend on streams flowing from the snow that used to lie throughout the summer on the higher peaks. The tremendous barrier of the outer range of the mountains prevent the monsoon from reaching Lahoul though some of it gets across the Rohtang Pass and falls in the Chandra Valley. But the Bhaga Valley depends entirely on its winter snow and on the glaciers for its water supply.

Slowly, slowly, in the course of ages, the mountains of Lahoul are being worn down and the glaciers are receding. When the level of the highest ranges wears down below twelve thousand feet the glaciers will have gone and Lahoul will have become a desert. One wonders where the Lahoulis will have trekked by then? Or, whether, long before that distant day, they will have all fallen off the roofs of their houses in infancy.

For travellers feeding is less difficult than might be expected in such a remote valley. We took with us stores of flour, sugar, butter and jam, etc., but no tinned meats, fish or fruit. Mutton is always available if you are prepared to buy a whole sheep at a time.

In that dry climate meat will keep for at least 10 days if protected from blue-bottles. Potatoes and onions were procurable and we heard (unfortunately too late to test it) that the leaves of Eremurus form a most delicious vegetable.

The Eremurus was in full bloom when we came to Kyelang and we had seen with amazement these long, slender, poker-like flowers growing in such profusion that the mountain slopes were massed with a creamy-yellow mist of bloom (Fig. IV, Plate 24).

Throughout June and July we were able to enjoy the wild rhubarb that grows in great quantities among the rocks above the river. The rhubarb was delicious, and—if cooked with a good pinch of soda-bi-carbonate—it needs very little sugar to make it as good as the English garden-grown variety.

Eggs were very scarce but those few which we got were monstrous things produced by fowls which are the descendants of the Moravian Mission fowls. Milk was plentiful but it is advisable to have your milk brought straight from the yak in a vessel of your own. Yak milk at any time seems apt to smell but when delivered at your door in a Lahouli milk-pail its smell is nauseating and does not yield to boiling

We only once sampled the famous Tibetan buttered tea. It looks and smells and tastes a bit worse than you'd expect it to. But I have known travellers who could appreciate it.

Such was Kyelang where we made our headquarters in Lahoul.

It was perhaps the least attractive place in all our journey, but it was convenient in many ways and in contrast to the next stage of our travels, Kyelang indeed seemed to be a thriving centre of progress and civilisation.

(*To be continued.*)

RIVERAIN FORESTS IN SIND, 1936—41

By D. B. Sothers, I.F.S.

Sind has some 7,00,000 acres of forests of which about four-fifths may be termed "riverain." The rough classification adopted is to consider those forests which are directly accessible to the river flood as riverain: the remainder is termed "inland forests." The main agricultural lands of Sind and the irrigation works that feed them are guarded from the Indus floods by the protective *bunds*. These are large earthworks, four feet higher than the maximum flood level and sufficiently broad on the top to carry a single motor road. They run from one end of Sind to the other at distances of 4 to 10 miles apart, except in the comparatively rare sections where the approach of natural high ground to the river makes them unnecessary. Between these *bunds* the Indus takes a course that is always varying.

Even the *bunds* themselves are not completely permanent and unchanging; they are at times eroded or threatened with erosion, when loop *bunds* have to be built behind them. Of the varying area which they enclose rather more than one-third is forest.

In these forests the *babul* (*Acacia arabica*) is the most important tree, closely followed by the *kandi* (*Prosopis spicigera*). *Lai* (*Tamarix galica* and *dioica*, also occasionally, *articulata*) is at times mixed with these trees, and also frequently forms a pure crop, particularly in the lower lying areas. *Bahan* (*Populus euphratica*) is fairly common and often regenerated naturally as a pure crop, particularly on the more sandy new formed lands near the actual course of the river. If silt deposits gradually improve these lands this pure crop of *bahan* may become undersown with *babul*, which sometimes with, and sometimes without, artificial help slowly replaces the *bahan*.

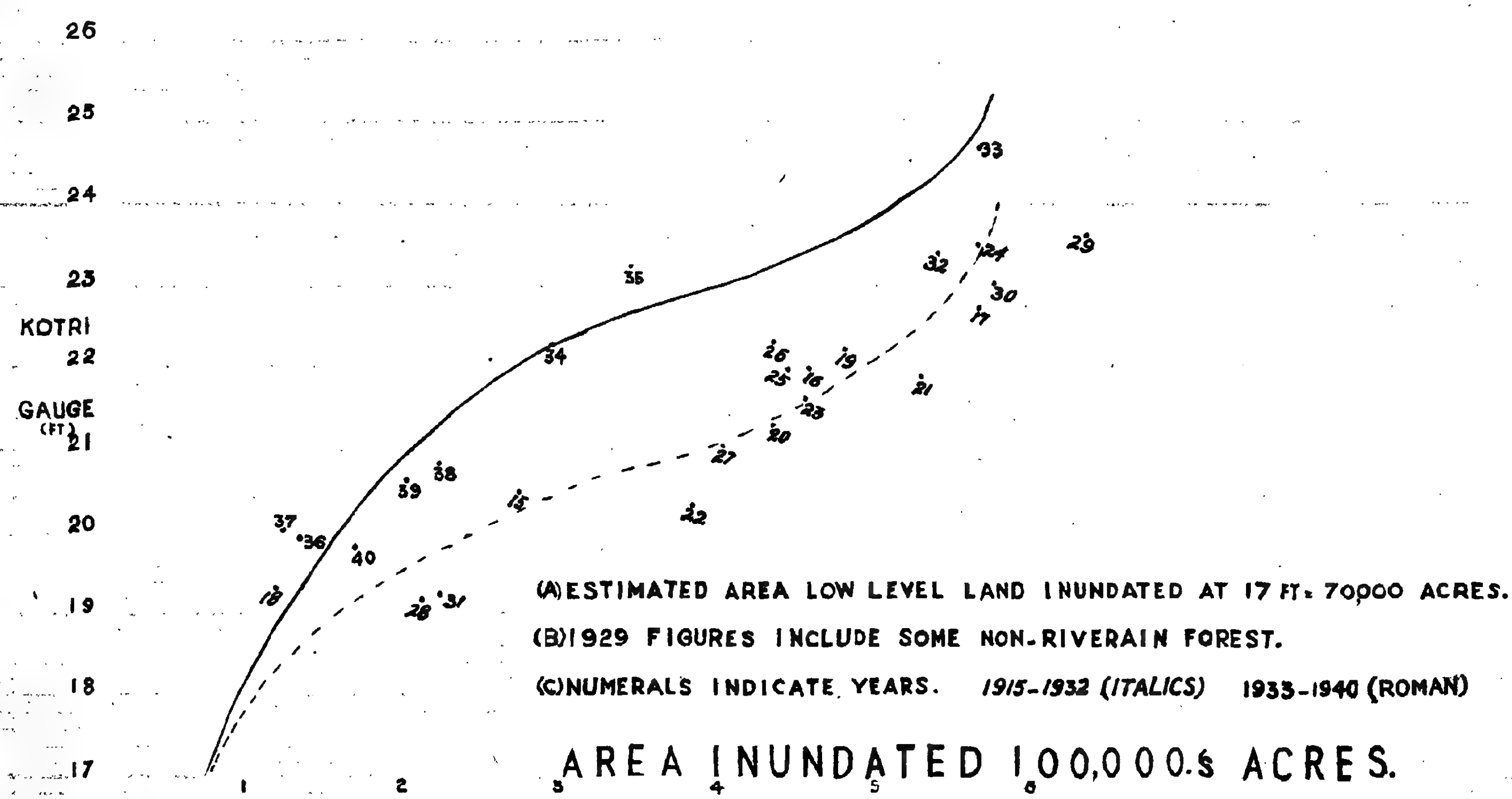
Rainfall and particularly summer rainfall is very infrequent in these forests. They are in consequence dependent for their existence almost entirely on the water they received from the summer floods in the Indus. Gauge readings for these floods have been taken at several stations in Sind for the last 70 years, but for all Sind Forest purposes the gauge readings at Kotri opposite Hyderabad are probably the most useful.

Now although at first sight the Sind forests appear flat, they are only comparatively so. Most of the area they occupy has at one time or another been occupied by the bed of the Indus and these old beds, after they ceased to form the main channel, have gradually silted up, but to varying heights.

Differences in level of five feet or so are therefore common and the maxima are often much more. A second factor of much importance is that generally speaking the higher levels are nearest the river and the usual slope is away from the river towards the inland as well as towards the south. A flood to be effective therefore must be of some duration, for the flood water may have to find its way inland up to distances of 10 to 15 miles. At times a direct flood overtops the bank, at others the water travels down old natural channels, sometimes by disused inundation canal heads and, on its way, may be required to fill up large areas of low-lying land or unsilted depressions. In consequence the peak gauge reading of one day only cannot be expected to give an accurate idea of what benefit the forests have received. For this purpose the average reading of the best 10 days' flood is probably the most useful.

Apart from the frosts of 1929-30, which did much damage, in 1935 the Sind riverain forests were on the whole in good condition. For the previous five years, and indeed for some years before that, the Indus floods had been very satisfactory. The average Kotri gauge reading (best 10 days) had been 22.6 and the area irrigated 3,87,000 acres. The five seasons 1936—40 have been continuously bad. The average reading has dropped by 2.2 feet to 20.4 and the average area irrigated to 1,67,000. The results of these poor floods did not make themselves apparent at once though by the end of the second year much damage was already obvious. Since then the situation has rapidly become worse and it is now estimated that at least 1,00,000 acres have gone out of productivity and probably considerably more. These areas contain dead trees only, or where these have been cut, nothing.

The damage is probably worst in Karachi, but Larkana Division, where the greater part of the Kandiaro Range has now reverted to desert, is not far behind. Above the Barrage the effects of the drought were slower to appear, but in the past two years Sukkur



KOTRI GAUGE (FT)
17
18
19
20
21
22
23
24
25
26
1
2
3
4
5
6
(A) ESTIMATED AREA LOW LEVEL LAND INUNDATED AT 17 FT = 70,000 ACRES.
(B) 1929 FIGURES INCLUDE SOME NON-RIVERAIN FOREST.
(C) NUMERALS INDICATE YEARS. 1915-1932 (ITALICS) 1933-1940 (ROMAN)
AREA INUNDATED 1,00,000's ACRES.

Division has also been badly hit. Very little greenwood is now left in Wahidpur Forest (8,500 acres) and its neighbour Sadhuja (11,000 acres) is not much better.

Under such conditions the *babul*, as might be expected, is the first to go, and two consecutive years of drought are usually enough for it. Better things were expected of *prosopis*, but these hopes have hardly been realised. It is true that in many of the inland forests this tree has continued to grow or, at any rate, to survive for a very long time mainly on rainfall with perhaps an accidental flooding at very rare intervals. Here perhaps hard conditions have caused it to develop the long tap-root for which it is famous, and this may have enabled it to live. But in the riverain areas, growing under more favourable water conditions, though probably on a more sandy soil and sub-soil, its stamina has been very disappointing, and from three to five successive years with no flood have finished off most of it.

Single years of poor flood have often occurred in the past, but such a succession of bad years has never before been recorded. The subordinate staff were inclined at first to blame the Barrage. This on the face of it is hardly a logical argument as the withdrawals through the old inundation canals in the *kharif* season were as large as the present withdrawals through the Barrage system. Further, the Barrage opened for the *kharif* season of 1932 and in that year, as well as the following three, the floods were uniformly high.

No other reason has yet been suggested, but a separate factor seems to exist which has aggravated the situation. If the area inundated is plotted on a graph against the Kotri gauge reading it will be seen that the results are not very satisfactory if it is attempted to draw one curve only.

If, however, two curves are drawn, one for years up to 1932 and the second for years after that date, a much better agreement is obtained, and one which shows that after 1932 a certain Kotri reading implies an area irrigated less by over 1,00,000 acres than it did before that date. The reason for this might well be the heavy and prolonged floods of 1929—30 followed by the record flood of 1933 in which year Kotri gauge reached 24.9 feet and a flood of over 21 feet was maintained for 44 days. It is possible that these floods

caused extensive silting over much of the forest, lifting its floor above the reach of the poorer floods which followed later.

The Indus River Commission Records confirm this theory to some extent. At two stations, Sukkur and Kotri, bi-weekly observations of the silt content in the river are made. These observations combined with the total discharge of the river at the two stations show that during the years 1926—34, 70.2 thousand million cubic feet of silt passed Sukkur, whereas 61.4 passed Kotri. The balance 8.8 thousand million cubic feet were presumably deposited somewhere between these stations. The years 1929 and 1930 were very active years in this respect and contributed $3\frac{1}{3}$ thousand million of the total. On this section there is some 9,00,000 acres of land and river between the *bunds*. If the silt had been deposited in an even layer all over this area it would still have been sufficient to cover it to a depth of over $2\frac{1}{2}$ inches. But conditions are not uniform, and the forest areas, situated as most of them are at a lower level and nearer the river, are liable to receive far more than their mathematical share. In the forest itself some parts are more favourably situated than others for silt deposit, and it appears therefore not impossibe that quite a large area, say 80,000 acres out of the 2,40,000 acres of forest in the section, should have been lifted to a foot higher level.

Theory and fact would agree very much better if the break in the graph had occurred from 1931 onwards. The position of 1932 might just be accepted but 1931, *in spite of the fact that the figures* for two Sukkur Ranges in that year are suspect, is right out of its proper place and there it must remain to mar what would otherwise be a reasonably consistent explanation.

Definite land level records would, of course, settle the point, but they are not available. In their absence the explanation offered must be considered as a theory only and one that is not capable of proof.

From what has been written it will be seen that the situation at the present moment is not good. It may improve in the immediate future but it is feared that this improvement, if it does occur, is likely to be only temporary.

Extensive schemes are understood to have been prepared in the Punjab for the withdrawal of large amounts of water in the *kharif* season from the whole Indus system. These schemes are to be the subject of arbitration between the Punjab and Sind Governments during the present year. If they are passed, and if the result of their operations is to bring the *Kotri* flood down by another two feet to 19 or less, the only fully fertile riverain forests left will be some 1,00,000 acres of the newest and lowest level lands set down by the Indus in the past few years. A further 1,00,000 acres of unirrigated forest may also be expected to remain in production where sub-soil or percolation water conditions are favourable

The problem would be how to extend this area of new low-level land at the expense of the older high lying areas. This is being done by the Indus itself at the present moment, but the process is too slow to give effective relief. Every year on an average some 9,000 acres of forest are eroded by the Indus from the banks against which the main current impinges, but this loss is set off by an approximately equal area of new land, or "kacho" as it is called, which the river deposits elsewhere. As a result the total forest area remains practically stable.

By no means all the area so eroded is old high-level land. Perhaps as much as 5,000 acres may be of this type; the remainder is new land re-eroded soon after its formation. Dividing this figure into the total area it will be seen that at the best it would take 100 years to build up a new low-level forest and that in actuality it might very well take double. Whether it would be possible to accelerate this erosion process is more than doubtful. At present no really practical method has been evolved of stopping erosion where it is not wanted. It might well prove to be equally difficult to reverse the process.

A second factor which may also affect the future of these forests is the formation of the Anti-Erosion Circle in the Punjab. There is obviously no reason to fear that the successful operations of this Circle will affect the total discharges of the Indus, but there is every reason to expect that they will affect the peak flood level and, by preventing rapid run-off, flatten down this peak considerably. This might benefit the part of the Sind irrigation system which depends

on the inundation canals. It would definitely harm the forests for even five months of a flood at 19 feet level would be of far less use to them than five days at 22 feet.

The situation is, therefore, unpleasing, but in one direction, at any rate, it has been possible to do something to improve it.

The floods stabilised for five years at a low level have enabled the staff to regenerate artificially, mainly with *babul,* very large areas of new formed land and also low-lying areas in the older forests: these areas formerly received too much water to allow successful sowings to be made.

The task has been attacked with vigour, particularly during the last three years, in each of which nearly 200 tons of seed has been sown, or double the previous average. Aided by three mild winters and, for the last two years, by the employment of paid labour, instead of the old "voluntary" (so-called) help given by the inforest graziers in return for their privileges, the results all over Sind, but particularly in Karachi, Hyderabad and South Larkana, have been excellent. Young crops, five-years-old downwards, have been established on 1,20,000 acres and the condition and stocking of these crops leave little to be desired. They have been established on low-level land so that if the flood level grows no worse they will always receive water. If the level improves, most of the crop is high enough to escape death by drowning, so its future should be assured.

Regeneration works in India often have to be carried out under unpleasant conditions. In Sind they are as bad as can be met with anywhere. The work has to be done under the September sun when the river is falling. In addition to the heat the receding water leaves behind it a steamy atmosphere, swarms of biting insects and a ground the consistency of a sticky snipe bog. The staff have done well to carry out large-scale works under these conditions. So far they have received little thanks for what they have done: it is in consequence pleasant to be able to give their excellent work some extra publicity in this note.

THE SACRED RIVER OF HINDUSTAN

BY RAI SAHIB PREM NATH KHOSLA, I.F.S. (*Retd.*)

The sacred Ganges which takes its rise in the mid-Himalayas (Fig. II, Plate 26), unifies in itself all castes, creeds and sects of Hinduism from Cape Comorin to the North-West Frontier (bordering Afghanistan). The river which knows no racial discrimination is a constant reminder not only to Hindus but to all, that the ultimate is one and the same: all the side-streams fall into the same river while the vast waters of the ocean are a permanent link between various peoples and countries.

Joyously achieving its existence through hills and valleys for about 170 miles, the Ganges debouches into the plains at Hardwar, the Mecca of the Hindus. Here, at all the bathing Ghats, with the exception of Brahm Kund (*Har ki pauri*) the rich and the poor, high castes and low castes—Brahmins, Kashatryas, Vaishas, Sudras and Untouchables—wash their sins, shoulder to shoulder, and, for the time being, become strangely oblivious of the existence of castes and creeds created and maintained by a religious hierarchy for its own ends. In the eyes of God and Nature one man as a human being is as good as another: in the eyes of priests, true philosophic contemplation must give way to practical politics and economic needs.

In its upper reaches the Ganges passes through deep gorges and defiles. For nearly 60 miles above Tehri town the valley is fairly broad, well-populated and rich in cultivation; annual rainfall varies from 30 to 40 inches and the altitude from 2,500 to 4,000 feet above sea level; even in mid-summer, when the days are hot, the nights are cool and pleasant.

Nearly 44 miles from Tehri at 4,000 feet above sea level is the small town of Uttarkashi with its broad fields, ancient temples and several shops. This is the favourite abode of hundreds of ascetics during the summer months and is the last Post Office in the valley of the Ganges. It has several big inns for the accommodation of pilgrims with their free kitchens for the poor and the needy. The most famous temple here is dedicated to the Goddess of *Shakti* (Power). A bronze pillar about one foot in diameter, with a trident on top, shoots 10 feet above the pinnacle. How far it goes

deep into the bowels of the earth is not known. During the Gurkha invasion in 1812—15 a serious effort was made by the invaders to carry away this sacred obelisk to their own country, but the deeper they dug, the farther down it seemed to extend. So the attempt was given up in despair and the Gurkhas returned to their country sadder but wiser men, fully convinced of the truth of the legend that the symbol of power goes down to the centre of the earth. The frustration of the Gurkha enterprise further strengthened the local common belief.

Sixteen miles further up the valley at a place called "Mulla," where two prominent spurs across the Ganges descend abreast, abrupt change is noticeable in the topography, flora and general formation of the surroundings. The valley narrows down to almost a gorge, the river rushes on with tremendous force and din over the steep bed strewn with huge granite boulders (*vide* Fig. II, Plate 27). *Chir* pine disappears and its associate, the *toon*, is replaced by alder along the the river bank. Here grassy slopes offer rich grazing—but the population is sparse. Higher up stray *deodar* and *kail* gradually make their appearance surmounted by fir, whereas *ban* oak replaces the alder and granite the sandstone. In these Himalayas the *chir*-pine belt is nearly 80-90 miles wide, extending deep into the interior: in the Punjab hills it barely exceeds 30 miles.

The sanctity of the Ganges is supreme from times immemorial. This implicit faith is instilled into the people by learned ascetics with allegorical stories such as follows: Once upon a time near Hardwar lived a miscreant, whose sinful deeds were the dread of the men and the talk of the angels. One day two big bulls were having a tussel on the wet sandy bank near Hardwar. They gradually worked into the main street which the miscreant happened to be crossing at the time. As the bulls attacked one another he was caught in the impact and crushed to death. In spite of his sins his soul was admitted into Heaven. The angels protested against the entry of such a sinner in their midst, but God justified it on the ground that the bulls had some wet sand of the Ganges sticking to their horns and when the dead man was crushed some of the sacred water in the wet sand had touched him and earned him salvation. So much sanctity is attached to the Ganges.

Fig. I

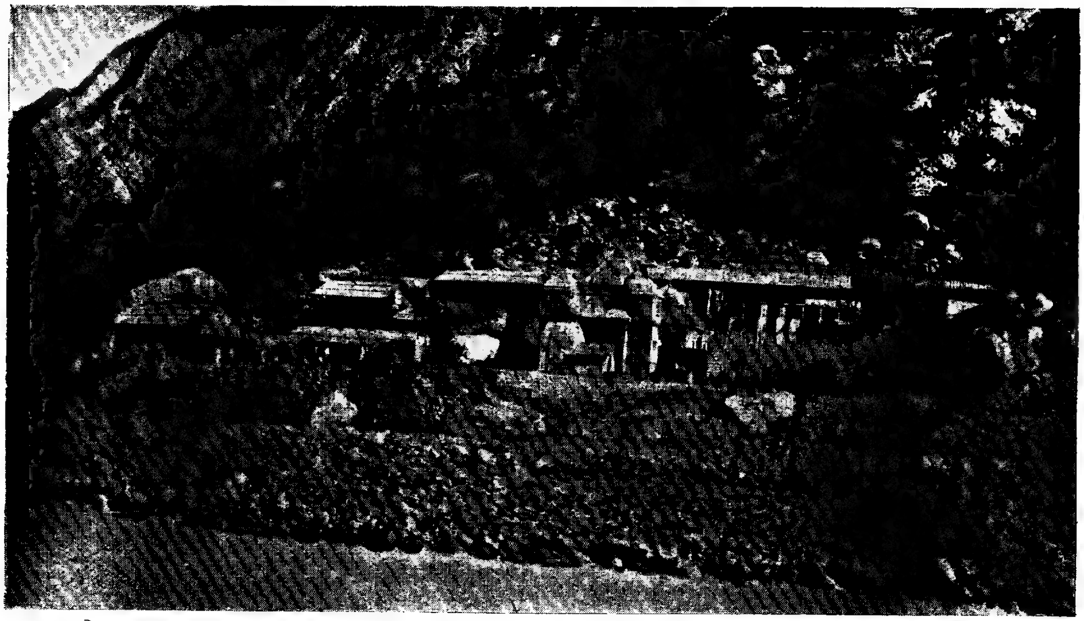


Photo: *P. N. Khosla.*

Gangotri temple which thousands of pilgrims visit every year. The age-long temple of the Deity was rebuilt some 18 years back by the munificent Maharaja of Jaipur State at a cost of nearly 1½ lacs of rupees. This temple contains the idols of Mother Ganges, the Jamuna and a few other deities.

The other buildings are inns for lodging the pilgrims.

Fig. II

Photo: *P. N. Khosla.*

The Gaumukh snow-clad pinnacles in the mid-Himalayas where the sacred Ganges takes its rise.

Fig. I

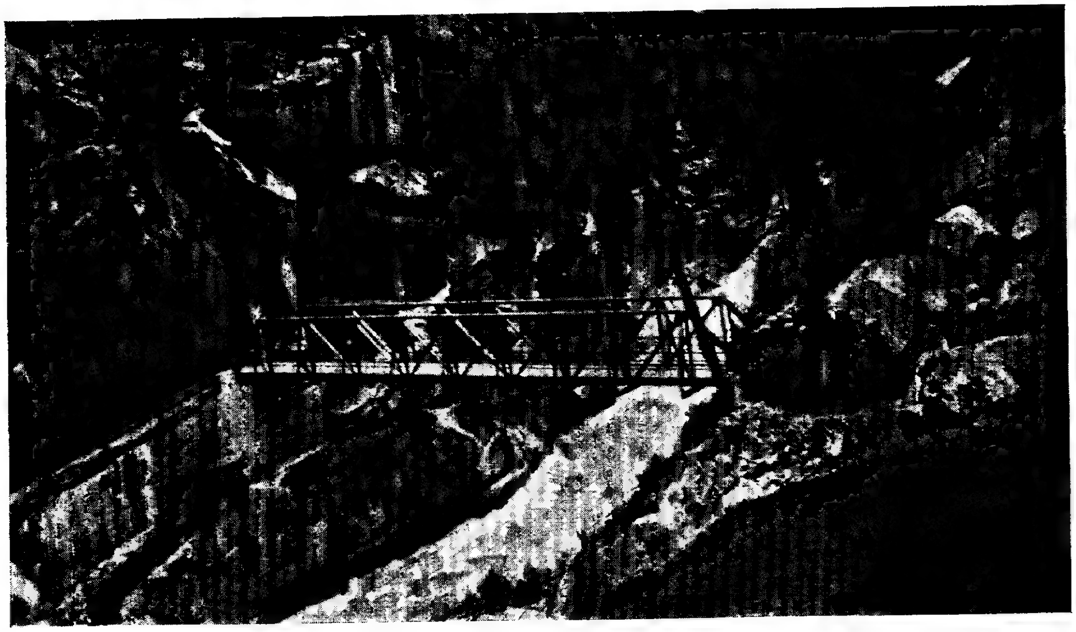


Photo: *P. N. Khosla.*

A modern steel-truss bridge built by the Tehri Darbar on Jad Ganga near Bhairon Ghati in recent years. On the right is a local deity in a palanquin, accompanied by devotees on their way to Gangotri for a sacred dip and obeisance to Mother Ganges.

Fig. II

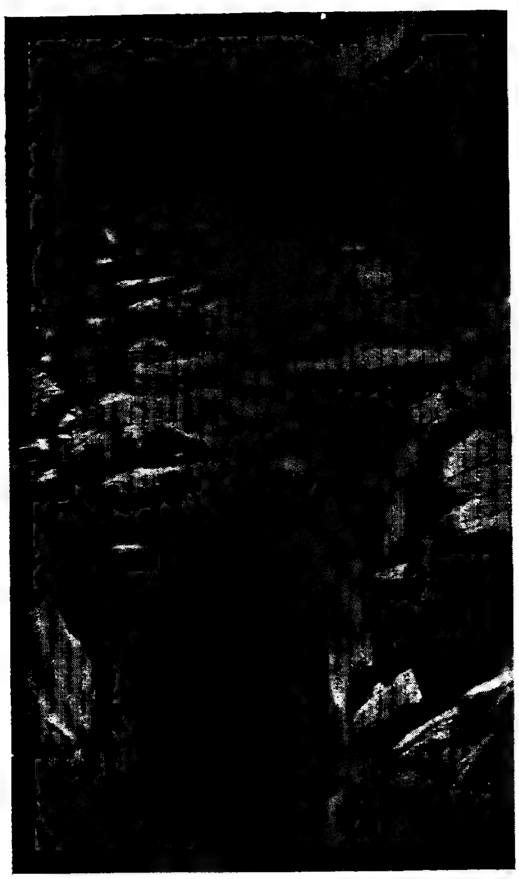


Photo: *P. N. Khosla.*

A very deep gorge where, nearly 400 feet above its waters, on perpendicular granite cliffs, is built a simple wooden bridge 30 feet in span. The river torrent rushes down with terrible force, causing terrific din.

Broadly speaking, such immense faith is found more among the poor than the rich. The religious fervour of the former is noticeable all over the world and has been so at all times. Their worldly belongings and physical comforts are so few in this world that they must perforce seek solace in praying for better luck in the next.

Thousands of pilgrims visit Gangotri (the source of the Ganges) in the summer months (*vide* Fig. I, Plate 26). Most of them are from the poorer classes. They come out with about Rs. 100 per head, representing probably their life's savings. It would be a poor compliment to the sagacity and service of the local priests and the people if the whole amount were not spent by the time the trek is complete. The valley is full of temples and deities and other religious spots associated with some fact from Ramayana or other religious books. For the comfort of the pilgrims rent-free inns or *dharmashalas* are available all along the route at short intervals of 8-9 miles. These are built and maintained by a great religious and philanthropic organisation of ascetics called "KALI-KAMBLI" (Black Blankets) which is supported by donations from wealthy and generous people of the plains.

The road, though rough and stony, goes up at easy gradient. It is fit for hill ponies and pack animals up to 10 miles below Gangotri and is kept in repair by the Tehri-Garhwal State. The Bhagirathi, as the Ganges is called in these parts, is crossed and recrossed at several places by light suspension bridges, except at two places where steel truss bridges have been built in recent years by the State (*vide* Fig. I, Plate 27). The side streams are spanned by simple wooden or canti-lever bridges depending on their width. The rope bridge at Nakuri, though not on the main route, is indicative of the old-type bridge from which the modern suspension bridge has developed. Coolies for transport can be had at a uniform rate of two annas per maund per mile. They are registered by the State officials at places of entry on payment of 5 per cent. of the wage bill. If a wayfarer is tired out *en route* he will most probably come across stray basket-carriers who are on the look-out for such cases and will carry the exhausted pilgrim in their basket on payment of three annas per mile. But if you are a heavy-weight, say 12 stones, the basket-*walla* will look askance at you, give you a wan smile and

disappear. For big bodies and well-off persons there are *dandies* at starting places, such as Mussoorie and Rikhikesh. These are carried by four, six or eight persons depending on the bulk of the person.

The pilgrims prepare their own meals at these halting places; shops to supply simple needs are there and sale rates are fixed. All along the route milk bars are found at short distances of three or four miles. Here hot milk can be had at four annas a seer. If you are hungry you can always take parched gram.

Immersed in their mental exaltation but weary of walking, the pilgrims pass along these hills through valleys and forest lands probably without much thought of the supremely beautiful scenery or of the beasts which might be lurking in the forest. Their long-drawn looks and woe-begone faces show that their immediate desire is to reach the next stage for rest, refreshment and obeisance to the gods and goddesses in the temples. Most of the pilgrims one comes across are ascetics or old, weary men and women "ugly as sin."

But the fallacy of this adage is proved here. A person may be ugly but still imbued with religious fervour. They accost you with *Jai Ganga Mai* (Hail Mother Ganges). The trek through Jamnotri, Gangotri and Badrinath takes nearly two months and I am sure they return home full of the glory of God, adoration of the deity, lighter in spirit and purse and bubbling with the grandeur of the hills, which in days to come they will relate to their grand-children sitting around the family hearth and to their village folk under the *pipal* tree.

In addition to the above information there are chapters written in popular language on log storage, air-seasoning, kiln-seasoning and wood preservation, and finally there is a comparative table of strength values for all the timbers described, and an index of trade, vernacular and scientific names.

The first edition of this booklet was published in 1929, and was well received. It filled a long-felt want for reliable information in tabloid form on the commercial woods of India.

The revised edition now published by the Government of India Press follows the same lines as the first edition, but is more comprehensive and informative. It is the kind of book which should find a welcome place, not only in the pocket of the man in the workshop but also on the desk of the director.

EXTRACTS

"TEN COMMANDMENTS"

1. Work hard. Hard work is the best investment a man can make.
2. Study hard. Knowledge enables a man to work more intelligently and effectively.
3. Have initiative. Ruts often deepen into graves.
4. Love your work. Then you will find pleasure in mastering it.
5. Be exact. Slipshod methods bring slipshod results.
6. Have the spirit of conquest. Thus you can successfully battle and overcome difficulties.
7. Cultivate personality. Personality is to a man what perfume is to a flower.
8. Help and share with others. The real test of business greatness lies in giving opportunity to others.
9. Be democratic. Unless you feel right toward your fellow men, you can never be a successful leader of men.
10. In all things do your best. The man who has done his best has done everything. The man who has done less than his best has done nothing.

CHARLES M. SCHWAB.

—*"The Allahabad Farmer," September*, 1941.

MODERN FIBRE BOARDS

Probably the first material ever used in building construction was wood, and it has been extensively used ever since. However, there can be few people who are not well acquainted with the defects of wood, such as cracking, warping, uneven grain, knots and the like, all of which give rise to unceasing troubles in use.

It was to overcome these defects that the modern fibre boards were developed. Although basically they are all composed of wood fibres of one kind or another, they have none of the defects of wood and are homogeneous boards of even thickness and large size; they are seasoned and treated against all forms of fungus and insect attack, yet can be worked with ordinary carpenter's tools.

These manufactured boards fall under two headings:

(1) *Insulation Boards*, the best of which are composed of sugarcane fibres loosely felted together, giving rise to a multiplicity of air sacs between the fibres, to which they owe both their great insulation value against heat and cold and also their sound absorbing effect.

These boards are largely used for the insulation of air-conditioned rooms and refrigerators and for the suppression of echoes and reverberations in cinemas and radio studios.

(2) *Hard Boards*, which are composed of wood fibres felted together under great pressure and heat to form hard, rigid, tough and homogeneous boards, and can be tempered against all atmospheric conditions for use in the open air.

These boards have an almost unlimited use in place of metal panels, plywood sheets, planks, etc. and have been successfully used for railway coaches, trams, lorry bodies, furniture, doors—in fact, anywhere requiring a rigid, smooth finish.

Both types of boards are extremely economical in use, due to the large sizes available, and every board in each class is identical with the next, both in finish and size, which greatly enhances the effect obtained in use and ease of construction. These properties are of particular importance where large areas of panelling are required, and hard boards, place at the disposal of the builder an ideal vehicle for this purpose, requiring no careful matching of grain and intricate joinery, as is the case with panelling.

Hard boards are available in various colours and they may also be painted or enamelled to produce strikingly beautiful or contrasting effects, which are so sought after for modern theatre and hotel decoration; whereas the natural nut brown tone with a high polish is the ideal for the more sober requirements of the home or office.

Both boards are manufactured on felting machines, similar to a paper-making machine, the fibres being obtained in the case of insulating boards by pulping cane, and in the case of hard boards by exploding natural timber with high-pressure steam. The size and consistency of the pulp is carefully controlled and chemicals are added to give protection against fungus, insects, moisture and fire.

The manufacture of these boards is one more instance of man's improvement on nature, since the great drawback to the use of natural products is that Nature never makes two products exactly alike, and any form of construction now-a-days must rely on a supply of materials the properties of which are accurately known and which are not subject to variation between one sample and the next.—*"Capital," Supplement, dated July,* 1941.

FISHING AFTER DARK

By H. C. Hollis.

Big bass feed at night. Not only do they feed at night but they feed in shallow water where they can be taken by surface lures. The scattered handful of anglers who know this reap yearly a harvest of finny prizes and thrilling experiences that no daylight bass fisherman will ever know.

The small-mouth bass, particularly the lake small-mouth, generally regarded as a deep-water fish to be taken chiefly by live bait, is especially active at night. The lake small-mouth spends most of the day in deep water, preferably where springs are abundant. When a minnow or frog is dropped on his nose, of course, he is likely as not to take it. Since most of the small-mouths caught during the day are taken by this method, many assume that this is the only effective one. But about the time that most fishermen

are returning to camp because of darkness the members of the small-mouth tribe start out to feed in earnest and they make an all-night job of it. It is then that angling offers its greatest thrill —a battle with a bass in the darkness. Pork chunk and lily pads at twilight are good and so are spinner-flies and fast water on a sunny afternoon, but the cream of angling pleasure comes on a placid lake at midnight with the shooting stars playing tag with the Milky Way and four pounds of hale and hearty bronze-back going south with a brown bass bug. Not the least of the attractions of night fishing is that specimens of four and five pounds and upwards are more common than under-sized fish; or, indeed, those weighing less than two pounds. Big bass feeds at night. No other type of angling calls for more skill or more exact methods than does night fishing. The angler must understand thoroughly the procedure required by the peculiar conditions. Good fishing starts about 9 P.M. and reaches its climax somewhere between 10-30 P.M. and midnight, although fish can be taken later than that. Clear starry nights are best. A full moon seems to have an unfavourable effect. It is vitally important to know where to fish. The fish will be feeding somewhere in the lake but the feeding grounds will comprise a few restricted areas where conditions are favourable. Good fishing for small-mouths is generally found around places where there is a sand or gravel bottom, with an abrupt drop-off from shallow to deep water. My own favourite place for night fishing is around the tip of a long, narrow peninsula. Often the feeding fish can be heard splashing in the shallows.

The fish will be in the shallow water near the shore and for this reason extreme caution must be exercised. If the boat or canoe is carefully handled one can stay within a short distance of the shore without alarming the fish. Twenty-five feet of line is generally enough to handle at night. Where the character of the beach permits, a good plan is to cast the lure to the shore and slip it gently into the water, this is more essential when using a bait-casting rod than when using a fly rod, since the heavier lures create more splash. For this reason a single-hook weedless lure is advisable for bait casters. Fly rod lures, however, such as bass bugs, feather minnows and dry flies bring the best results.

I have had practical demonstration time and time again that dark-coloured lures bring the best results at night. My own favourite night fishing lure is a brown bass bug. For bass bugs and feather minnows the usual procedure for handling such lures is followed. Let the lure lie motionless on the water for a moment. Twitch it gently and repeat. The strike generally comes when the lure is motionless.

Night battles with bass are long-drawn-out affairs. The fish gets many breaks he does not get in daylight and he makes the most of the time and leaps are frequent. There is an infinitesimal but none-the-less thrilling period of suspense between the splash that marks a leap and the assurance that the quarry is still hooked. We've all lost so many that way!

Large-mouth bass will also be taken at night, although this fish does not do so great a proportion of his feeding after dark as does the small-mouth. Wall-eyed pike and panfish will also take surface lures at night. Those who discount the wall-eye's ability as a fighter never hooked a big one on a bass bug at midnight. In the gleam of a flashlight (which is just as essential a part of the night fisherman's equipment as his rod), a wall-eye's great transparent orbs shine as brilliantly as do a deer's

Take a companion with you when you go fishing at night. The middle of a big lake at midnight is the most lonesome place in the world when one has only the bats and, perhaps, an occasional deer for company. Conversation is not taboo. The fish will stand any reasonable amount of noise. It is the unnecessary noises created by careless casting or clumsy handling of the boat that spoil the fishing. Night fishing also gets bass and wall-eye in the rivers but this is much more difficult than lake fishing. It is best to find a place which can be fished from the bank or from a canoe. If you plan to wade a river at night be sure you know the location of every rock and obstacle beforehand. Fish the likely places around rocks and logs and near the shore. In the current use a small spinner in addition to the floaters.

You'll like night fishing.—*Forest and Outdoors*, dated June, 1941.

TIMBER

Raw materials, which though not providing very impressive export figures at present are capable of immense development, are to be found among India's timbers and fine woods.

When one considers the vast coniferous forests of the Himalayas, the teak and valuable furniture woods of the jungles of the Western Ghats and the availability of many and varied timbers in the jungles of the central parts of the country, it is obvious that the 1939-40 export of Rs. 17 lakhs worth of these materials is very small in relation to the vast potential. Of this amount teak alone accounted for nearly Rs. 4 lakhs. This figure does not of course include Burma teak, which nowadays enjoys a world market. It might, however, be pointed out that fine grades of teak have always been available in India itself and that the famous wooden East India men, some of which were afloat for more than a century, were built at Bombay of teak obtained on the west coast.

To-day it is reckoned that the annual yield of timber and fuel from India's forests amounts to about 290 million cubic feet a year. In British India 94,457 square miles, or over 11 per cent. of the total area, is forest-covered and there are also extensive tracts in the States.[1]

According to the timber price list issued by the Forest Research Institute, there are some 28 different Indian woods already in commerce and in some instances as many as a dozen different grades of one kind of timber are recognised.

They include Baing (*Tetrameles nudiflora*) from Assam (also well known on the west coast), a white soft wood; Benteak (*Lagerstrœmia lanceolata*) from the west coast, a reddish brown moderately hard wood, in considerable demand and used for furniture, coffee cases, ship-building, etc.; Bijasal (*Pterocarpus marsupium*), a very hard, close-grained durable wood which takes a high polish and is much used for door and window frames, furniture and agricultural implements; obtainable in Bombay, Madras and Bihar.

Of the conifers, Blue Pine (*Pinus excelsa*) from the N. W. F. P. and the Punjab is much in demand, large quantities being floated

down the rivers to the plains. The wood is moderately hard and is much used in constructional work. The trees are also tapped for their gum. Chir Pine (*Pinus longifolia*) which also comes from the N. W. F. P., the Punjab and the United Provinces, has moderately hard wood, which though not quite as good as Blue Pine is cheaper and in considerable demand.

Deodar (*Cedrus deodara*), the Indian Cedar, is one of the most famous timbers of northern India and comes from the valleys of the Punjab and Kashmir. It is a moderately hard wood, strongly scented and oily; much used for railway sleepers and in building.

Spruce and Fir (*Abies* and *Picea* species), soft white woods similar to the European species, are available in the Punjab.

Dhupa (*Vateria indica*), the Indian Copal tree, found along the foot of the Western Ghats, besides giving the gum resin which makes an excellent varnish resembling copal, may be used for tea chests, packing cases, etc. Local boat makers use Dhupa for masts.

Civit (*Swintonia floribunda*) from Bengal is a greyish white, soft, even-grained wood and is said to last better than other woods in salt water. Another well-known timber which is found on the west coast and in the evergreen forests of Eastern Bengal and Burma is Gurjan (*Dipterocarpus species*). Available particularly in Bengal and Assam, it is a reddish brown hard wood with a well-marked silver grain. Some of the species yield a wood oil which is much in demand in the areas where they grow. Timber is used for boat building and packing cases.

Gamari timber from the tree (*Gmelina arborea*) is yellowish or reddish white, with a glossy lustre. Even-grained, soft, light and strong, it does not warp or crack and is very durable under water. Boats, buoys and packing cases and much ornamental work are made from it and it is commonly employed wherever wood shrinkage is to be avoided. Found almost throughout India, Gamari is particularly available in Orissa and Eastern Bengal.

Haldu (*Adina cordifolia*) is another timber with almost an all-India availability, being obtainable in Assam, Bombay, Central Provinces, Madras, Bihar and Orissa. A yellow, moderately hard,

even-grained wood, which is good for turning, furniture and cigar box making.

Hopea (*Hopea parviflora*) is a brown wood, hard and close-grained, from the damp forests of Malabar and South Kanara. It is a beautiful wood, much used in temple building in South Kanara; it is not eaten by white ants.

Indian Rosewood or Blackwood (*Dalbergia latifolia*) is of course world-famous, but not so well known outside the country as its relative Sissoo, otherwise known as Shisham (*Dalbergia sissoo*).

Rosewood is found in many parts of India, reaching its best in the forests of the southern part of the Western Ghats, though it is also available in the Central Provinces and Orissa. Extremely hard and close-grained, this dark purple wood is very widely used for furniture making, and except for sandalwood, southern rosewood is about the highest priced timber in India. Shisham is the northern forms of the species, being available in the United Provinces, the Punjab and Bengal. Less expensive than rosewood, the wood is very hard, close-grained and brown in colour. J. S. Gamble in his *Manual of Indian Timbers* describes it as "probably the finest wood in India" for furniture and carving and adds: "It is in regular demand for these purposes all over the North." It takes a high polish. Sissoo is also much used for carriage, cart and boat building, having lightness as well as strength and elasticity.

Irul wood (*Xylia xylocarpa*), one of the hardest woods in India, is available in Madras. Being very durable it makes excellent railway sleepers and can also be used as paving blocks, piles, telegraph posts, etc.

The Indian Laurel (*Terminalia tomentosa*) and its relative Kindal (*T. paniculata*) are both important timbers, the Laurel being found in many parts of the country (wood available in Bombay, Central Provinces, Bihar, Orissa and Madras) while the Kindal occurs in the south. Laurel wood is dark brown, very hard and beautifully variegated with streaks of darker colour. Kindal, also hard, is grey.

A dark red, extremely hard and heavy wood is Mesua, sometimes known as Nahor (*Mesua ferrea*) used as railway sleepers and obtainable in Madras. It also grows extensively in Assam.

Next on the list is the Indian Mulberry (*Morus alba*) available in the Punjab. Like its relatives outside India, its fruit is eaten and its foliage used for silkworm culture. The wood is yellow or yellowish brown, has a pretty silver grain and is used for furniture, boats, agricultural implements, etc.

Perhaps the most decorative wood available in India is Padauk (*Pterocarpus dalbergoides*), a relative of Bijasal, already mentioned, found in the forests of the Andaman Islands. The heartwood, bright red and streaked with brown and black, is much in demand in Europe and America for furniture, parquet floors, etc. The wood is durable and moderately hard.

Sal (*Shorea robusta*), available in Assam, Bengal, Bihar, Central Provinces, Orissa and the United Provinces, is one of the most extensively used woods in Northern India. The heartwood is brown, coarse-grained, hard and has a remarkably fibrous and cross-grained structure. It is much used in building for piles, beams, planking door and window posts and for railway sleepers.

Sandalwood (*Santalum album*), which may cost over Rs. 600 a ton, is available in the dry regions of South India and yields a hard, very close-grained yellowish brown wood, strongly scented by the oil characteristic of this tree. The wood is most commonly used for boxes and small articles, often beautifully carved, while India also possesses the important sandalwood oil industry.

Sandan, whose scientific name *Ougeinia dalbergoides,* is said to be taken from the city of Ujjain in Central India where the tree grows freely, is an excellent furniture timber, being hard, close-grained and mottled light brown in colour. Available in the Central Provinces, Bihar and Orissa.

Semul (*Bombax malabaricum*), the silk cotton tree with the spectacular flowers and masses of cotton, yields a very soft white timber useful for planking, packing cases, toys, etc. Available in Assam, Bihar and Madras.

Sundri (*Heritiera species*) is notable for its extreme toughness. The timber is very hard and close-grained with dark red heartwood. Available in Bengal, it is extensively used for boat building, furniture, beams, planking and posts.

Finally, we have Teak (*Tectonia grandis*), the chief export wood of India and Burma, and world-famous for its extraordinary durability probably due to the large amount of oil in the wood. As a ship-building wood and for good house carpentry it has long been known in many parts of the world. In India it is a general-purpose timber for house and ship building, bridges, railway sleepers, furniture, etc. Teak has two main areas: Peninsular India (it is available in the Central Provinces, Madras and Bombay) and Burma. The timber is moderately hard and when freshly cut is a deep golden yellow, turning brown and finally nearly black with age.—*Indian Information,* Vol. 9. No. 80, dated September, 15, 1941.